US009248327B2

(12) **United States Patent**
Polan et al.

(10) **Patent No.: US 9,248,327 B2**
(45) **Date of Patent: *Feb. 2, 2016**

(54) **CONCEALED HORIZONTAL SIDEWALL SPRINKLER**

(71) Applicant: **The Reliable Automatic Sprinkler Co., Inc.**, Liberty, SC (US)

(72) Inventors: **George S. Polan**, Liberty, SC (US); **Oliver S. Pahila**, Liberty, SC (US); **Thomas L. Multer**, Liberty, SC (US)

(73) Assignee: **THE RELIABLE AUTOMATIC SPRINKLER COMPANY**, Liberty, SC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 165 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/015,036**

(22) Filed: **Aug. 30, 2013**

(65) **Prior Publication Data**

US 2013/0341054 A1 Dec. 26, 2013

Related U.S. Application Data

(63) Continuation of application No. 12/871,859, filed on Aug. 30, 2010, now Pat. No. 8,573,316, which is a continuation-in-part of application No. 10/974,397, filed on Oct. 26, 2004, now Pat. No. 7,784,555, and a

(Continued)

(51) **Int. Cl.**
A62C 37/08 (2006.01)
A62C 31/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A62C 31/02*** (2013.01); ***A62C 35/58*** (2013.01); ***A62C 37/14*** (2013.01)

(58) **Field of Classification Search**
CPC A62C 35/00; A62C 35/68; A62C 37/11; A62C 3/0029
USPC 169/37, 38, 40, 42, 16, 19, 39, 41
See application file for complete search history.

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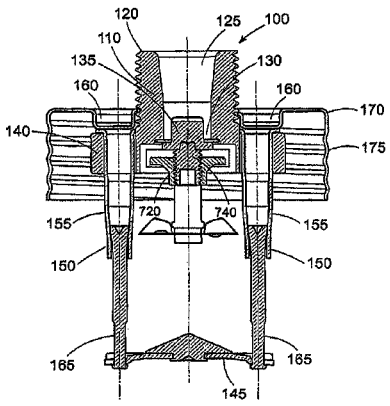
Primary Examiner — Davis Hwu
(74) *Attorney, Agent, or Firm* — Fitzpatrick, Cella, Harper & Scinto

(57) **ABSTRACT**

A horizontal sidewall fire protection sprinkler has a deflector having a vertical face, transverse to the fluid flow from the output orifice, and a horizontal shelf positioned above and perpendicular to the vertical face. A portion of the horizontal shelf extends in the fluid flow direction by a first length, with respect to the vertical face, and this first length is less than about half of the total length of the horizontal shelf in the fluid flow direction. The sprinkler may be installed in a support cup having a raised mounting platform configured to receive the sprinkler body and a cylindrical outer surface. A horizontal or pendent fire protection sprinkler has a body having an output orifice and a flange and a seal cap to seal a flow of fluid from the output orifice and a thermally-responsive element positioned to releasably retain the seal cap. Housing members extend through and from the flange of the sprinkler body, and contain rods, each of which extends through the flange. A deflector is connected to ends of the rods.

4 Claims, 22 Drawing Sheets



Related U.S. Application Data

continuation-in-part of application No. 11/848,103, filed on Aug. 30, 2007, now abandoned, which is a continuation of application No. 10/974,106, filed on Oct. 26, 2004, now Pat. No. 7,275,603.

(51) **Int. Cl.**

A62C 35/58	(2006.01)
A62C 37/14	(2006.01)

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FIG. 1

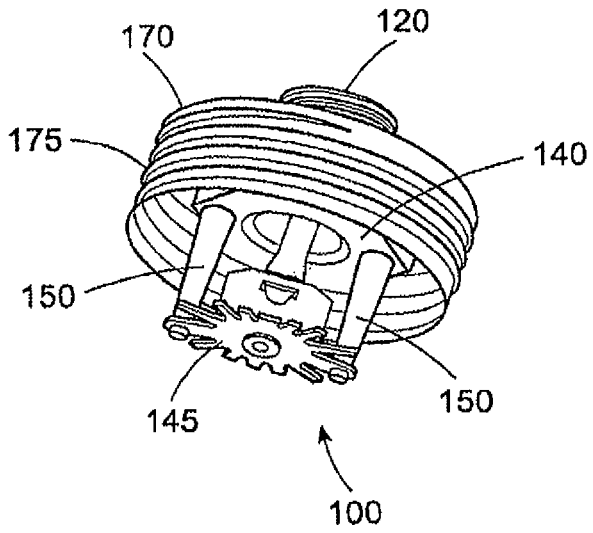
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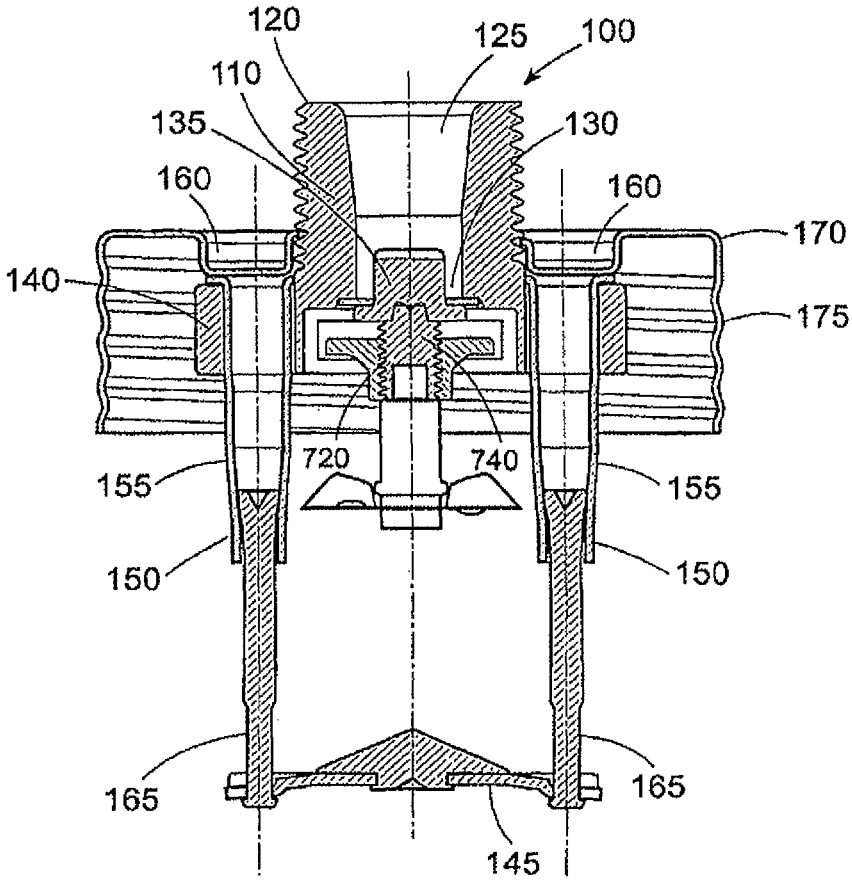
FIG. 2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175
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740
155
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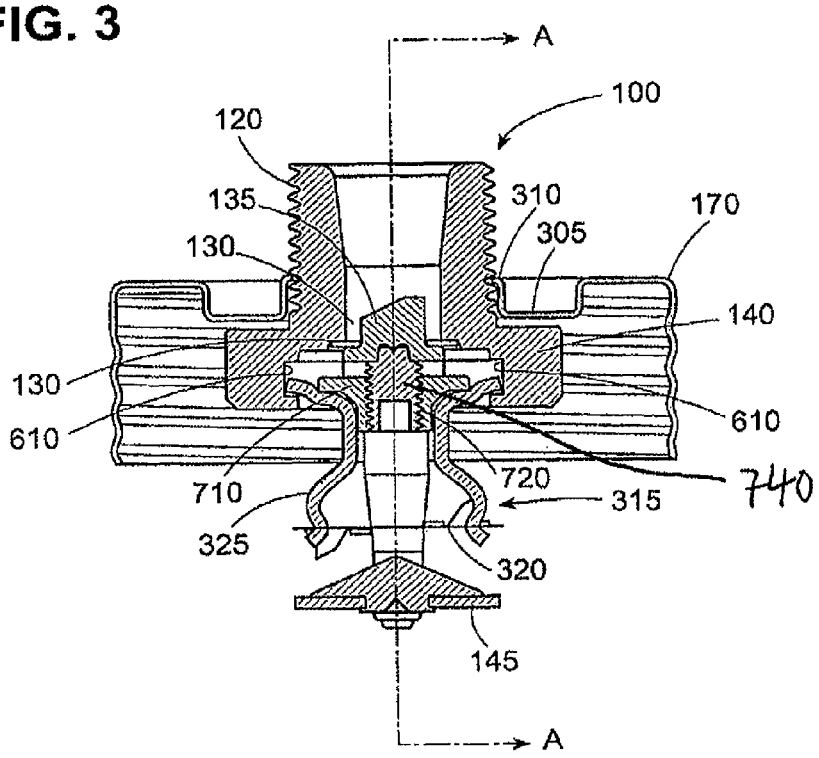
150
150
165
165
145

FIG. 3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315
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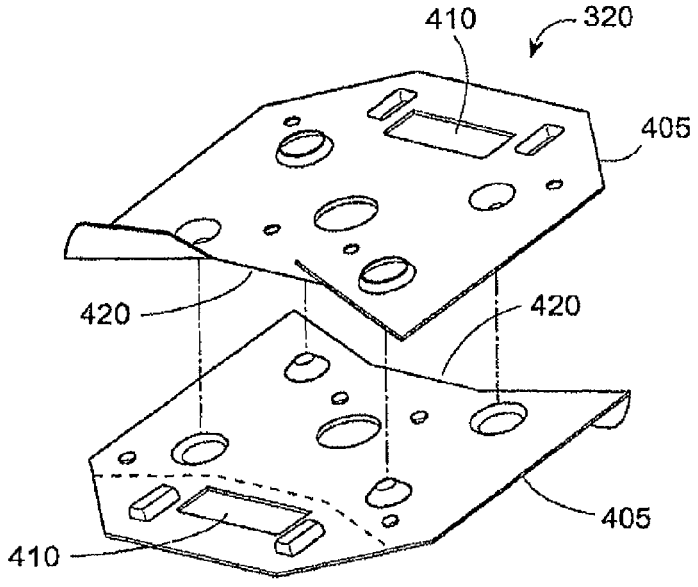
320
145
A

FIG. 4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420
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FIG. 5

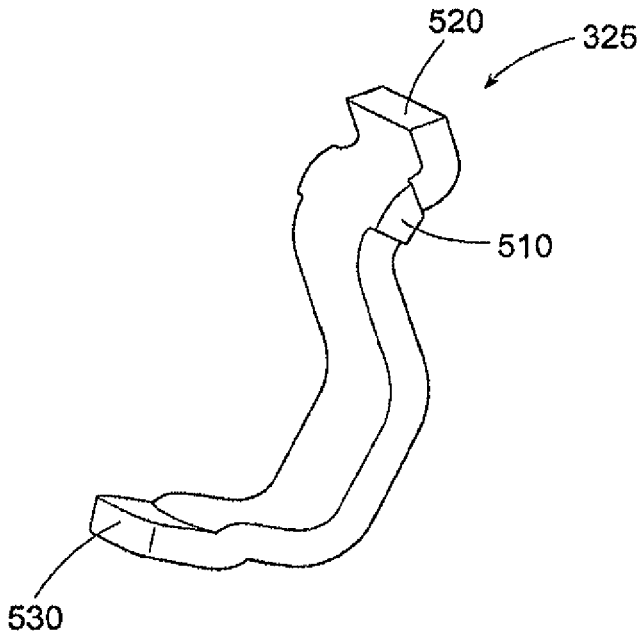
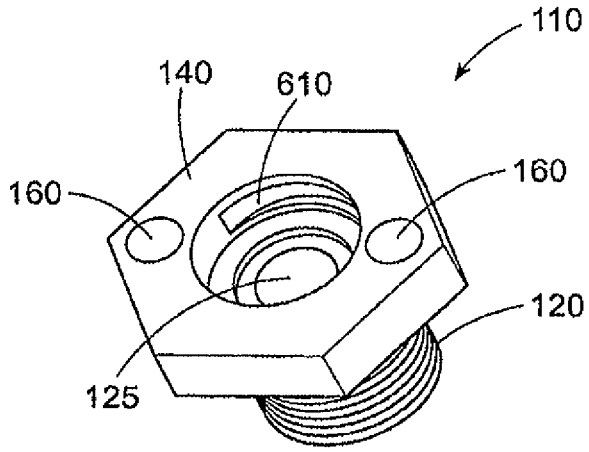


FIG. 6



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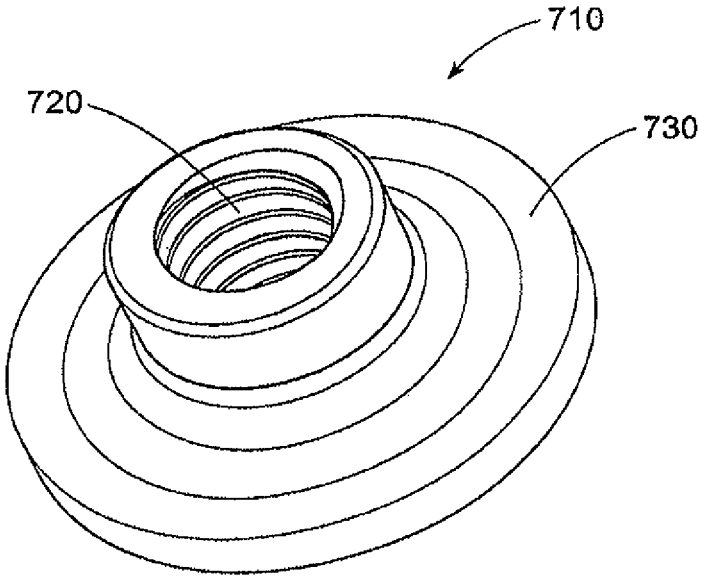
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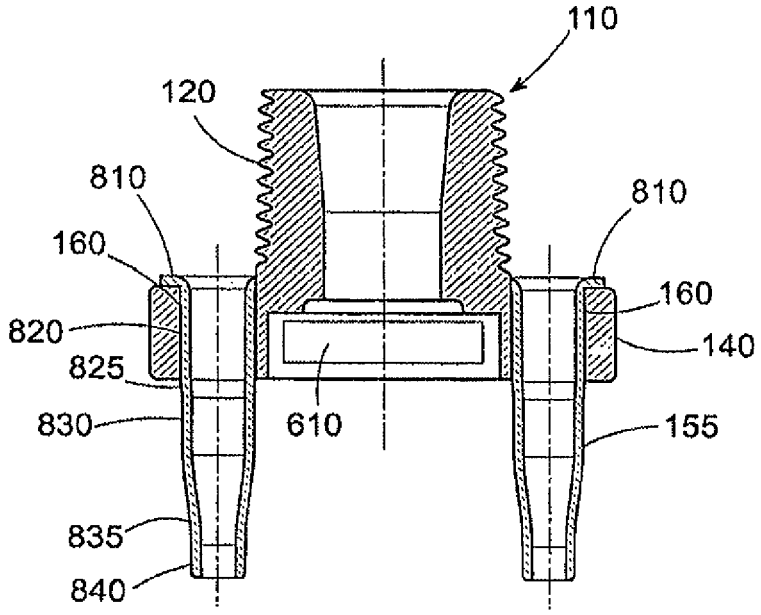
FIG. 8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140
825
830
610
155
835
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FIG. 9

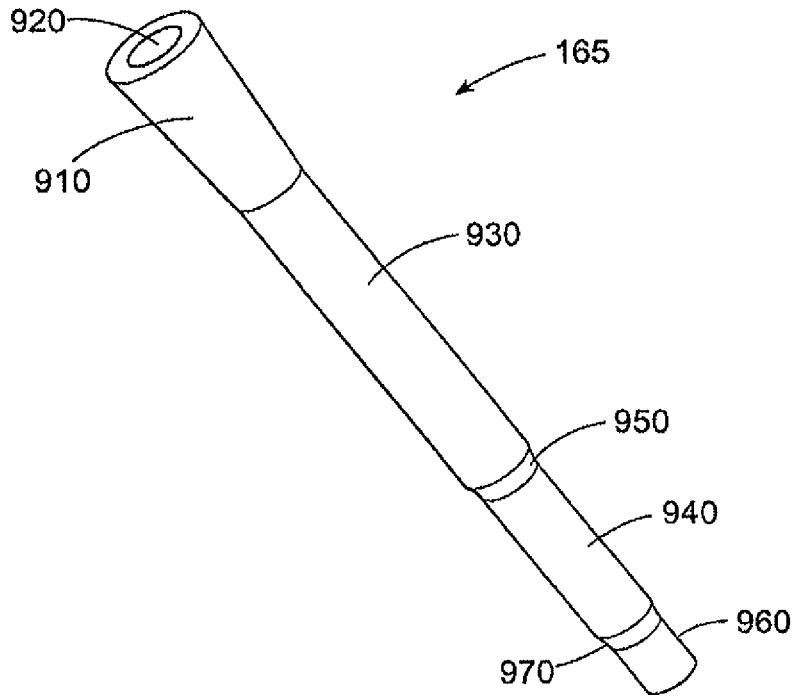
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FIG. 10

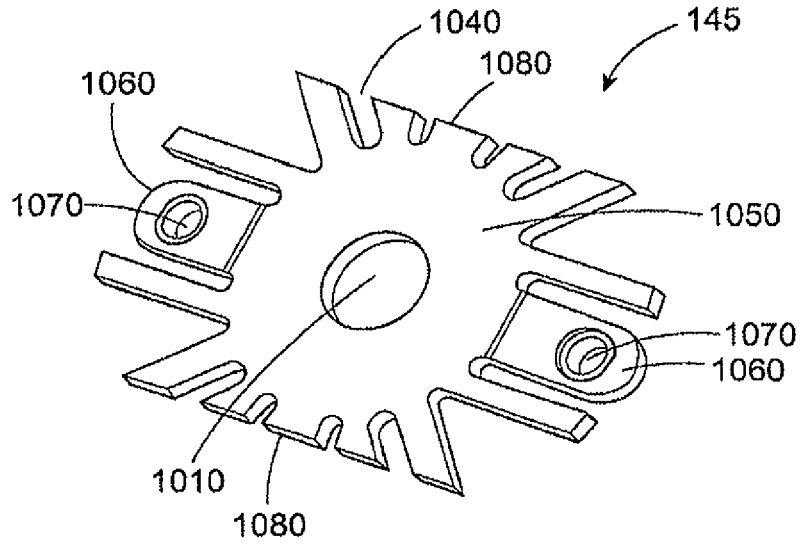
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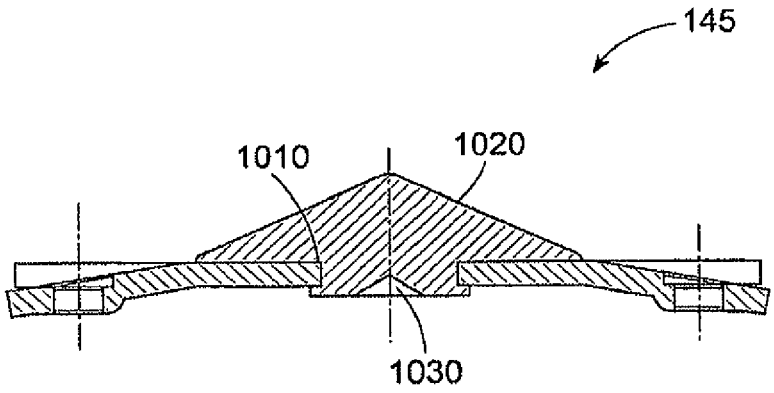
FIG. 11



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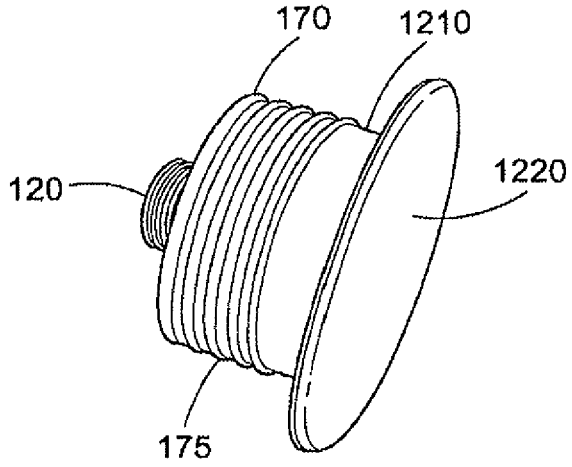
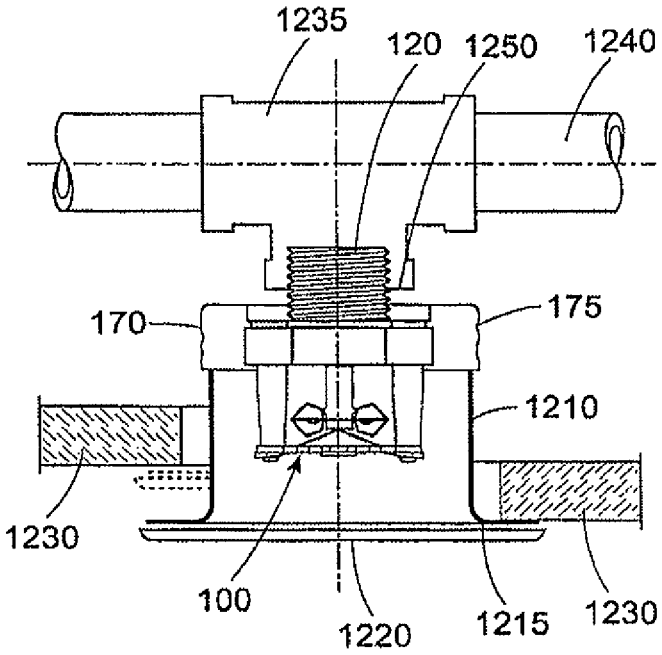


FIG. 13



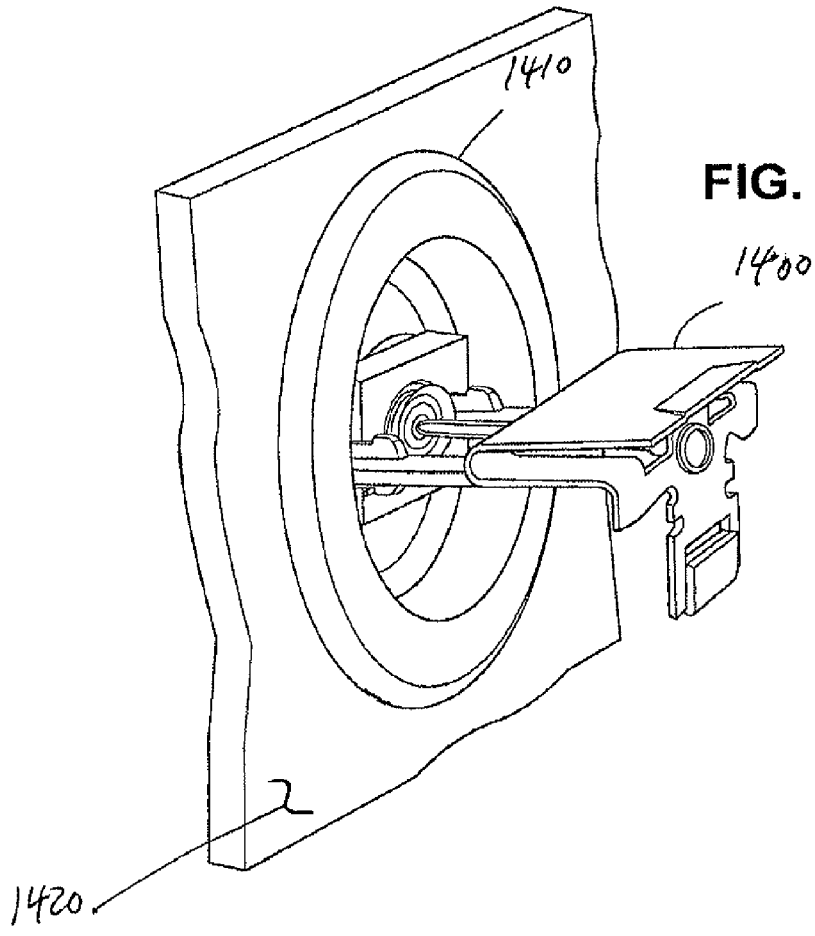


FIG. 14

FIG. 15

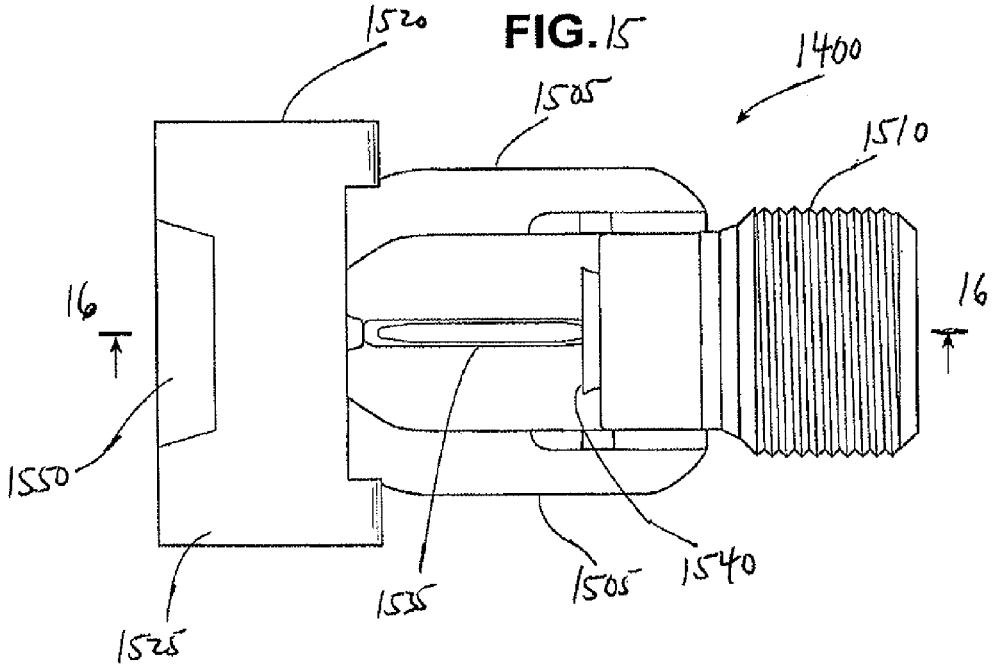
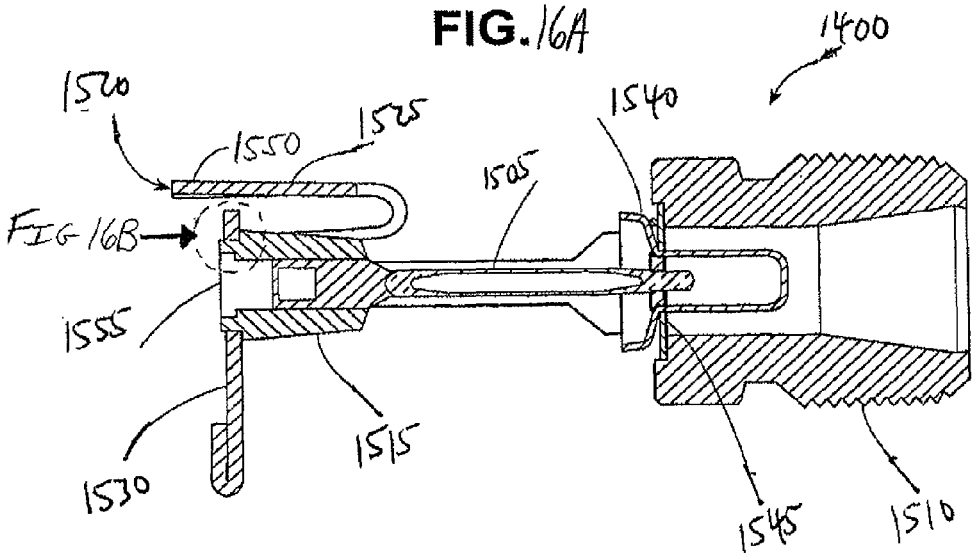


FIG. 16A



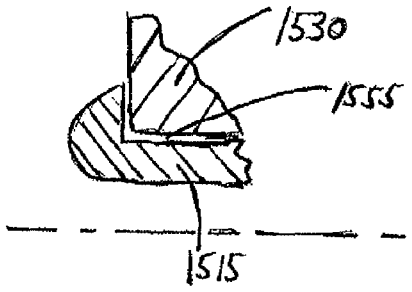


Fig. 16B

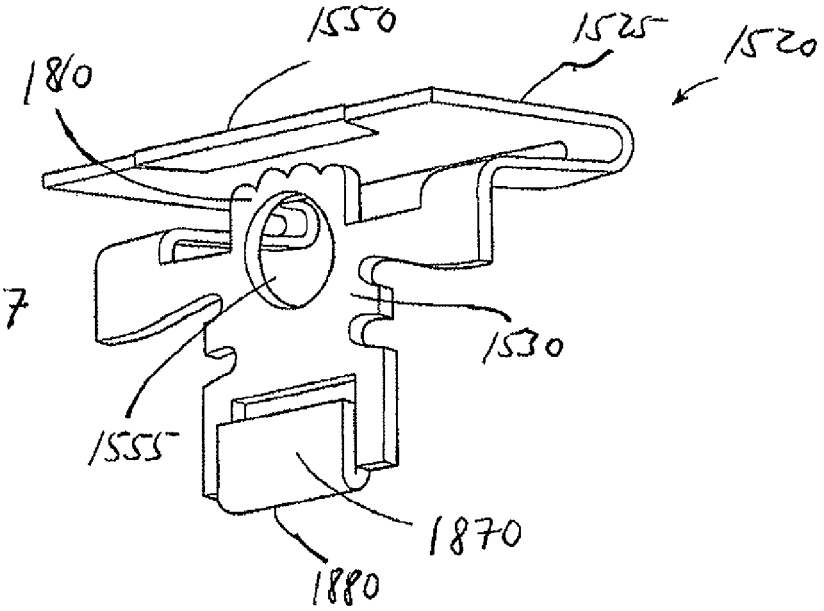


FIG. 17

FIG. 19

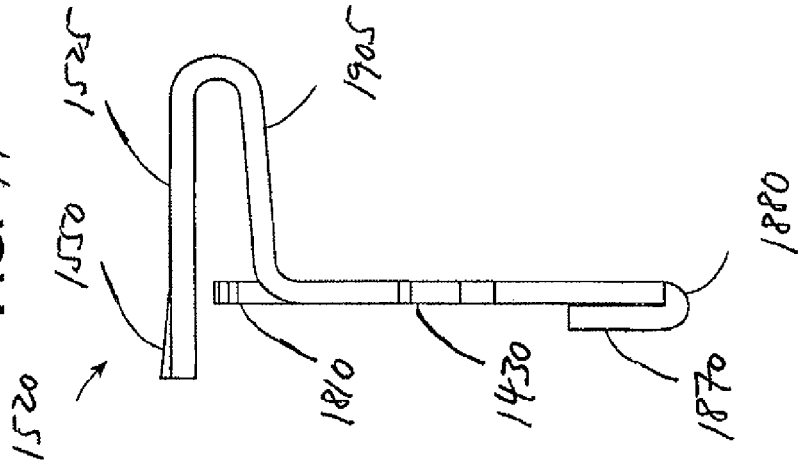

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FIG. 18

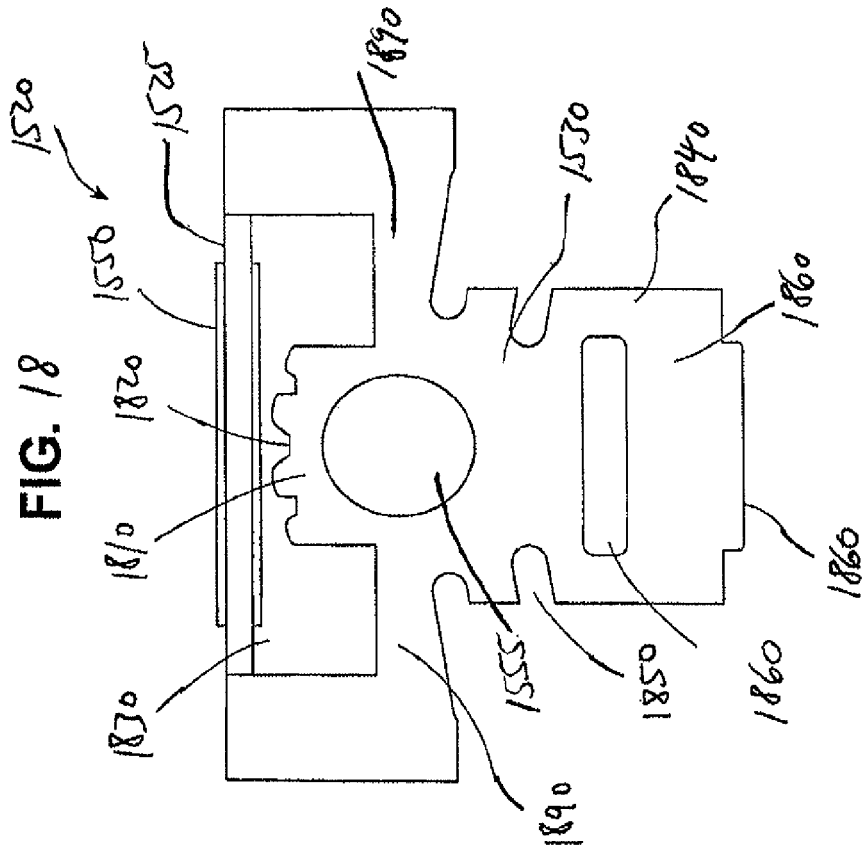
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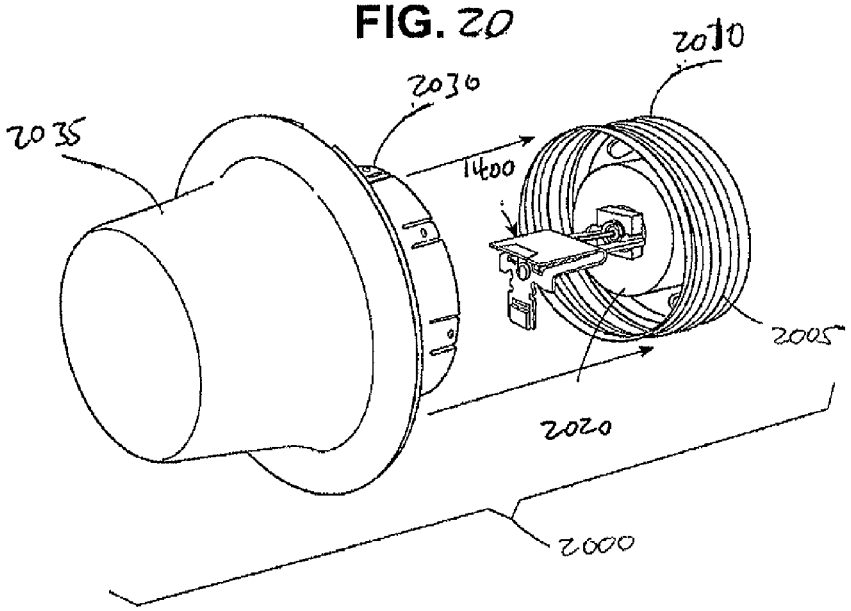
FIG. 20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2020
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FIG. 21

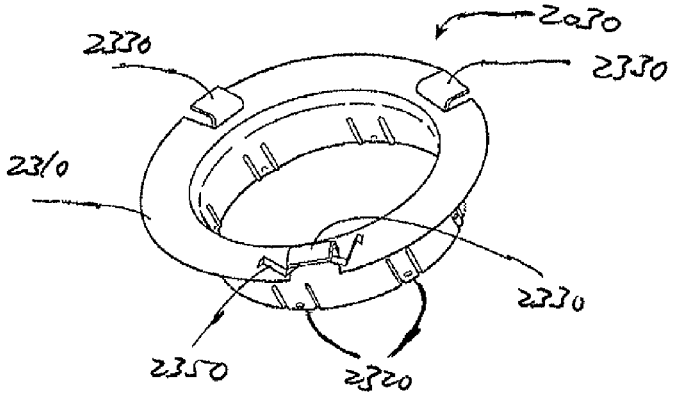
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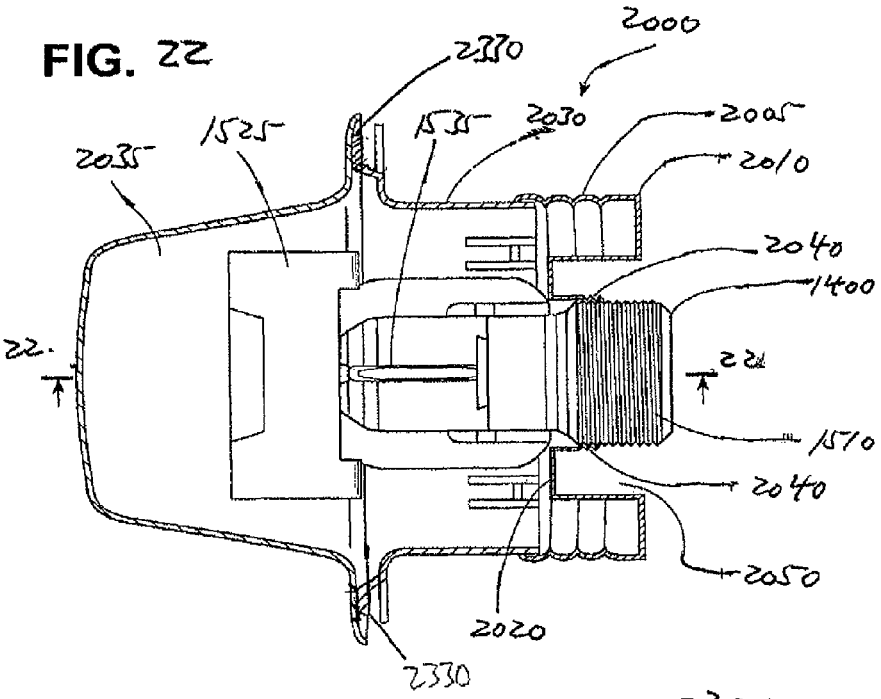
FIG. 22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22
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2050
2020
2330

FIG. 23

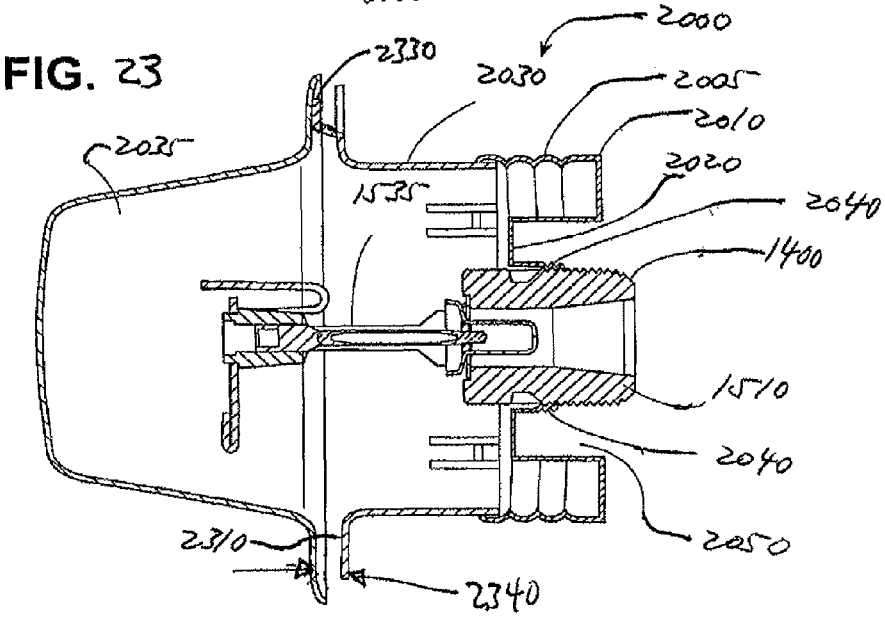
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FIG. 24

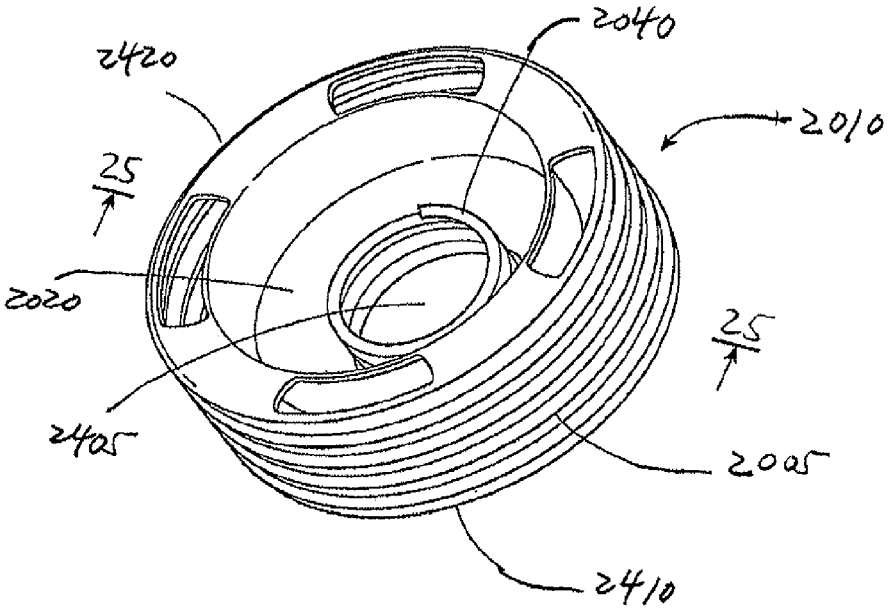
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FIG. 25

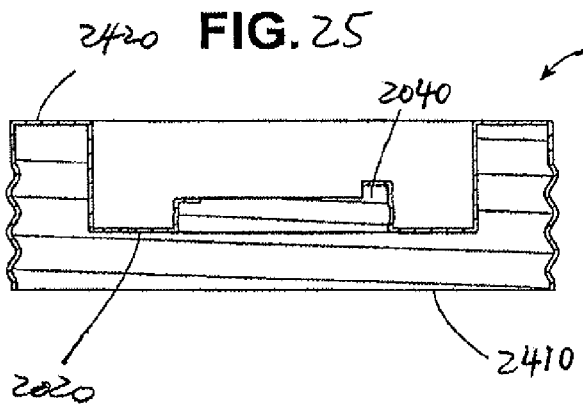
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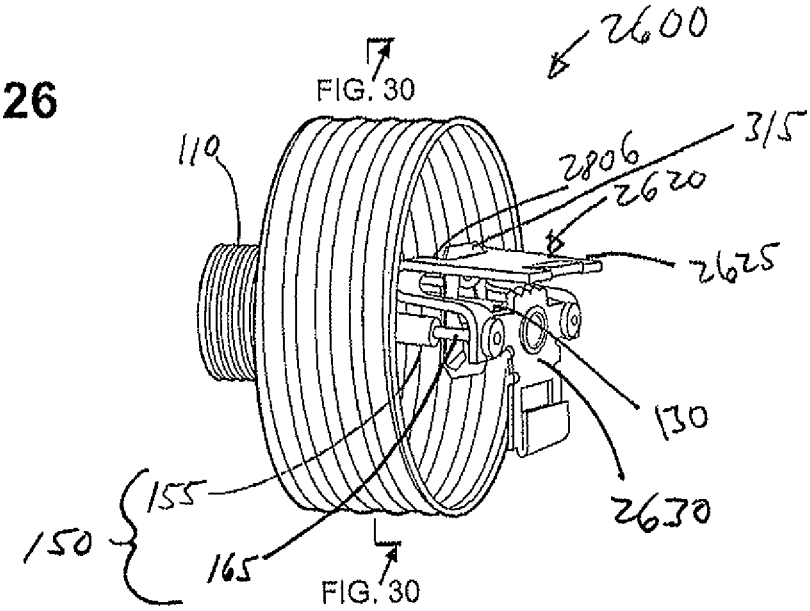
FIG. 26


2600
FIG. 30
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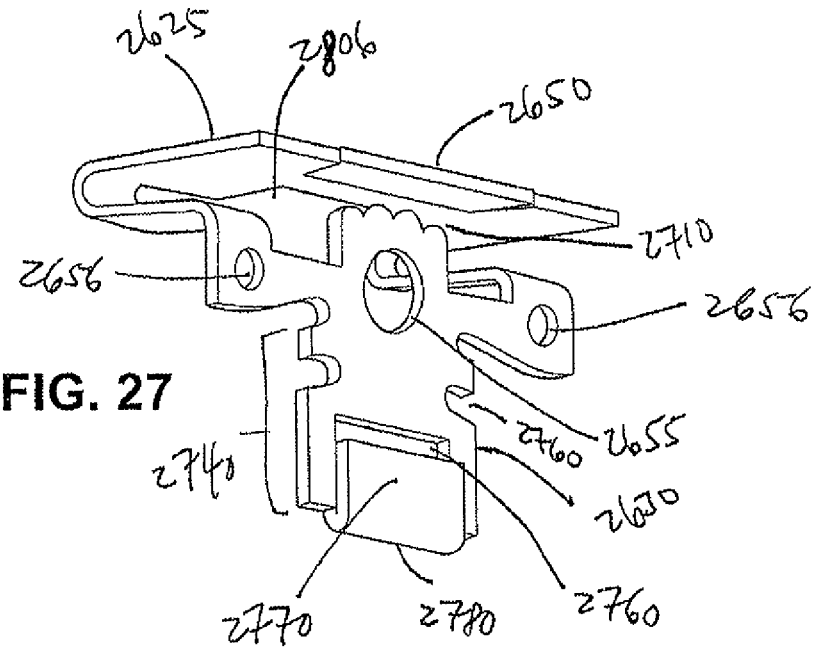
165
2630
FIG. 30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2780
2760

FIG. 27

FIG. 29

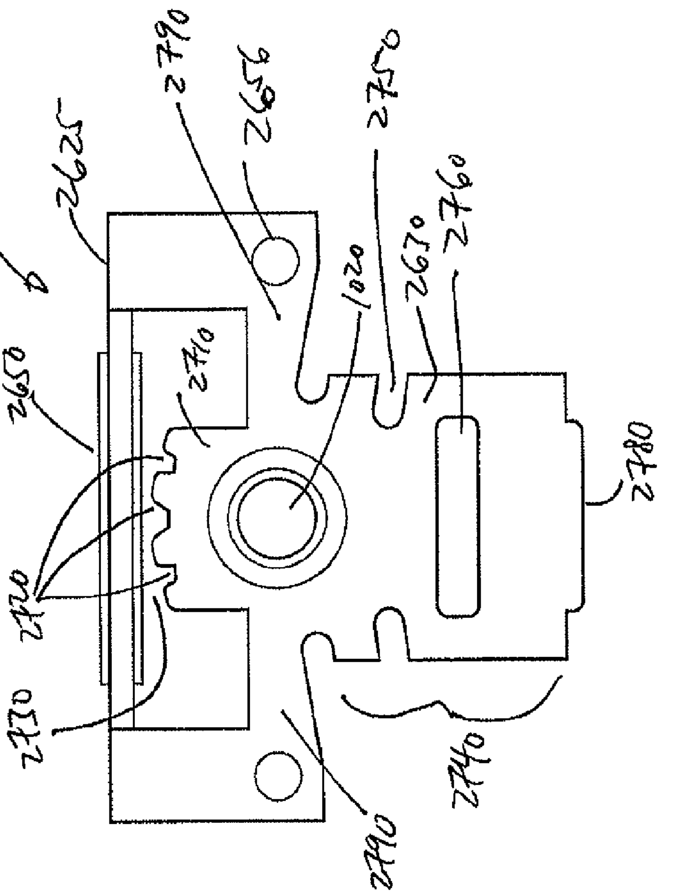
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FIG. 28

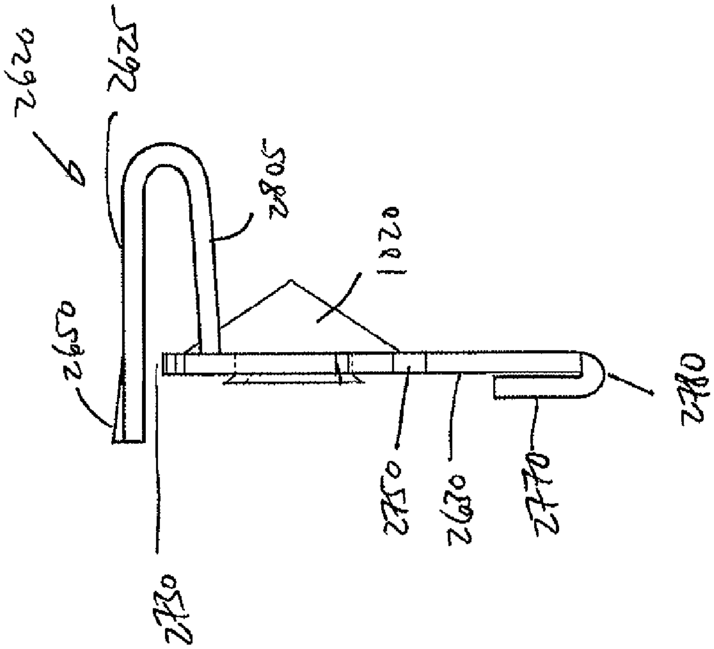
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FIG. 30

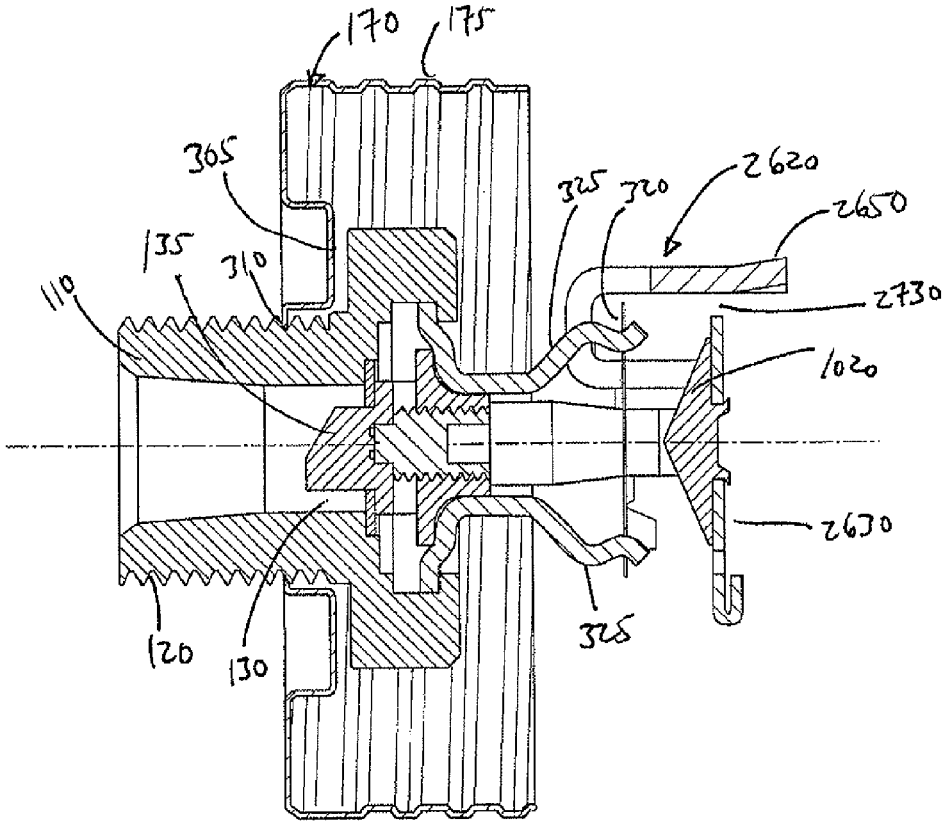
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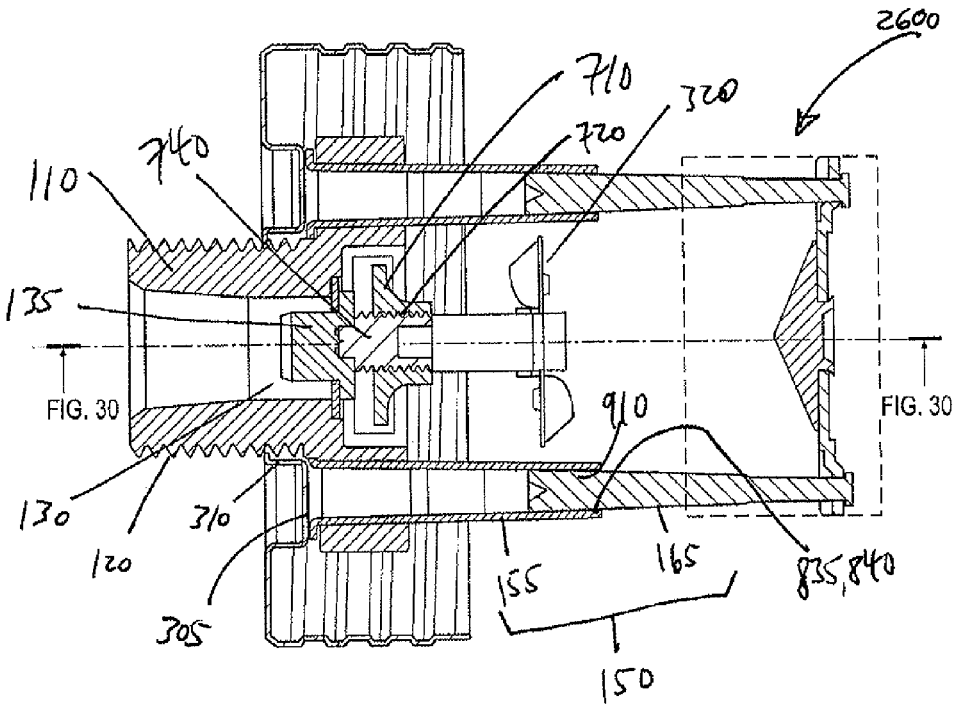
FIG. 31


2600
710
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110
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FIG. 30
FIG. 30
910
130
120
310
305
155
165
835,840
150

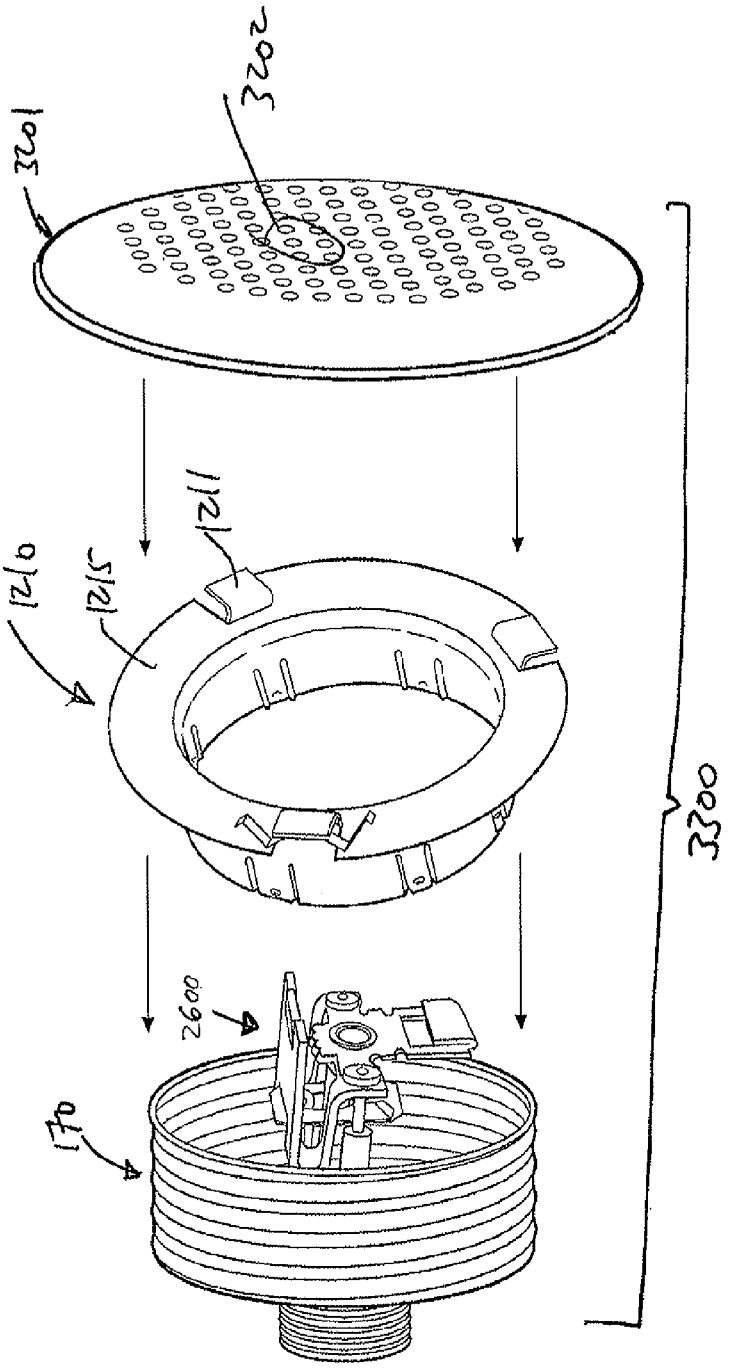


FIG. 32

FIG. 33

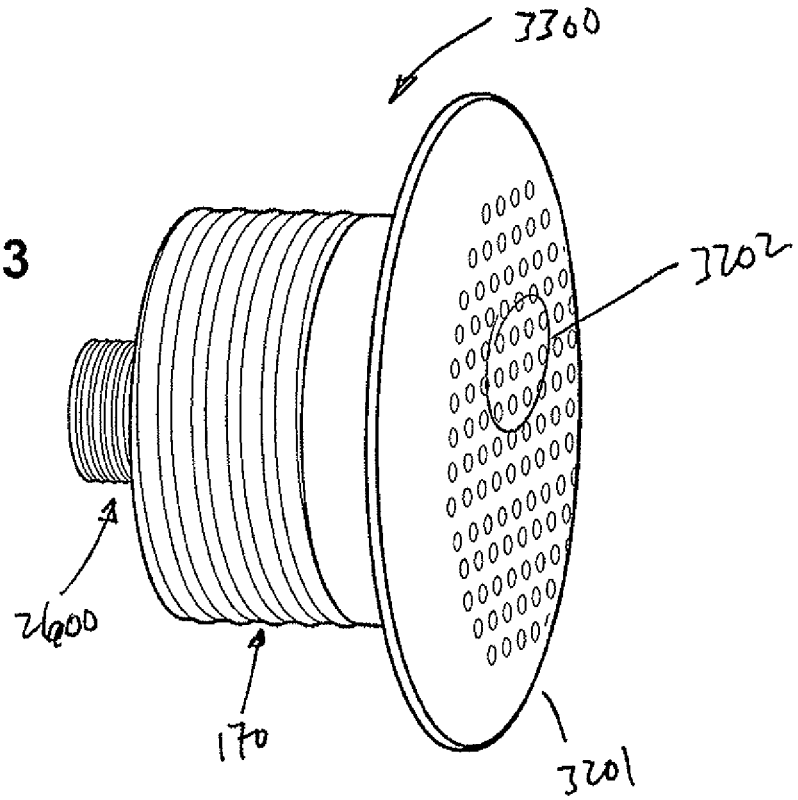
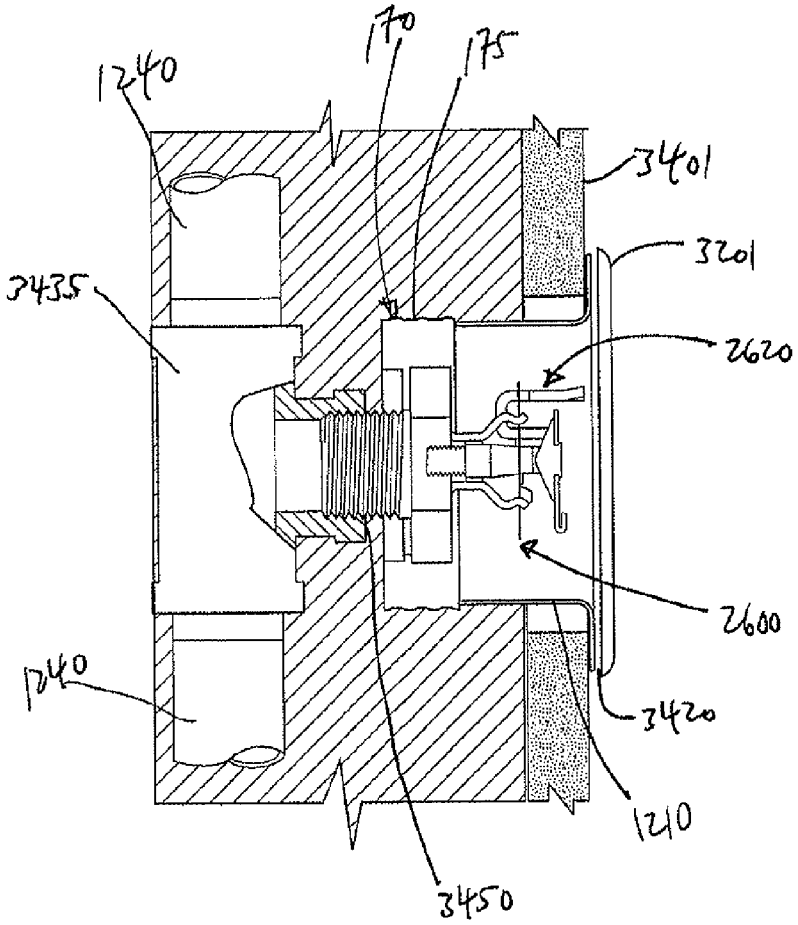


FIG. 34



CONCEALED HORIZONTAL SIDEWALL SPRINKLER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 12/871,859, filed Aug. 30, 2010 (now U.S. Pat. No. 8,573,316), which is a continuation-in-part of U.S. application Ser. No. 10/974,397, filed Oct. 26, 2004 (now U.S. Pat. No. 7,784,555), and which is a continuation-in-part of U.S. application Ser. No. 11/848,103, filed Aug. 30, 2007 (now abandoned), which is a continuation of U.S. application Ser. No. 10/974,106, filed Oct. 26, 2004 (now U.S. Pat. No. 7,275,603), the entire contents of each of which are incorporated herein by reference.

BACKGROUND

1. Field of the Invention

The present invention relates to a pendent fire protection sprinkler with a drop-down deflector. The present invention further relates to concealed pendent sprinklers for residential applications. The present invention relates to horizontal sidewall fire protection sprinklers, including those having a deflector with a rearwardly positioned horizontal shelf, which reduces the overall length of the sprinkler to provide a low-profile configuration. Such sprinklers may also be mounted in a supporting cup having a raised platform, with an escutcheon and cover, to provide a concealed configuration with improved sensitivity.

2. Related Art

Fire protection sprinklers conventionally are connected to a conduit to receive pressurized fire-extinguishing fluid, such as water. A typical sprinkler has a base with a threaded portion for connection to the conduit and an output orifice to output the fluid to provide fire control and/or suppression. The output orifice is sealed by a seal cap, which is held in place by a release mechanism. The release mechanism is designed to release the cap under predetermined conditions, thereby initiating the flow of fire-extinguishing fluid. A typical release mechanism includes a thermally-responsive element, e.g., a frangible bulb or a fusible link, and may include a latching mechanism.

Fire protection sprinklers may be mounted on a fluid conduit running along a ceiling and may either depend downward from the conduit, which is referred to as a "pendent" configuration, or may extend upward, which is referred to as an "upright" configuration. Alternatively, a sprinkler may be mounted on a wall, a certain distance below the ceiling, which is referred to as a "horizontal sidewall" configuration. Horizontal sidewall sprinklers have an output orifice that is oriented so that the fluid is output horizontally and sprays onto an area to be protected in front of the sprinkler. The area to be protected may extend across an entire room, in which case the relevant fire protection standards, e.g., Underwriters' Laboratories® Standard 1626, require the fluid flow to reach a particular height on the four walls surrounding the coverage area, among other requirements. Horizontal sidewall sprinklers are particularly useful in applications in which overhead piping is not easily installed, e.g., in residential applications.

Certain conventional sprinklers have a pair of arms that extend from a base, with the arms connecting at a hub. The hub is spaced apart from the output orifice of the base and is aligned with a longitudinal axis thereof. The hub may have a set-screw configured to apply a force to the thermally-responsive element and latching mechanism to maintain the seal cap in a position in which it seals the output orifice. A deflector is commonly provided, and may be mounted on the hub, transverse to the output orifice, to provide dispersion of the output fluid.

Other sprinklers have a deflector that is attached by a pair of arms that extend from the base of the sprinkler, but do not meet at a hub. In such sprinklers, the thermally-responsive element holds the seal cap in place without being held in compression by a hub. For example, U.S. Pat. No. 4,976,320 shows a sprinkler having a deflector attached to the body with arms that do not meet at a hub. The arms extend from the sprinkler body, and a drop-down deflector is attached to the sprinkler via two guide pins, which are installed in holes in a bent portion at the bottom of each arm. U.S. Pat. No. 5,664,630 shows another example of a sprinkler with a drop-down deflector.

U.S. Pat. No. 6,374,919 shows a horizontal sidewall sprinkler having a deflector with a horizontal shelf. The forwardly-extended portion of the shelf (approximately 0.6 inch) is greater than half the total length (approximately 1.0 inch) thereof. The sprinkler is mounted in a cup with a cover. The cup is mounted in a cavity in the wall such that the flange of the cup is flush with the wall surface. A cover is mounted on the flange so as to leave a gap therebetween to allow air flow to enter.

Technical bulletin "Series LFII Residential Horizontal Sidewall Sprinklers 4.2 K-factor" (Tyco Fire Products, Lansdale, Pa., April 2004) shows a horizontal sidewall sprinkler having a deflector with a horizontal shelf. The shelf is perpendicular to the frame arms and is approximately 0.7 inch in length, as measured from front edge to back edge near the center (the front edge faces away from the output orifice). The shelf appears to extend at a slightly upward angle with respect to the horizontal axis and has a protrusion in the center of the forward edge. The shelf extends approximately 0.43 inch beyond the major vertical surface of the deflector (i.e., the surface transverse to the fluid flow). Thus, the forwardly-extended portion of the shelf is approximately 61% of the total length thereof.

Technical bulletin "Series TY-L—5.6 K-factor Horizontal Sidewall Sprinklers, Standard Response, Standard Coverage" (Tyco Fire Products, Lansdale, Pa., January 2003) shows a horizontal sidewall sprinkler having a deflector with a horizontal shelf. The shelf is parallel to the frame arms and is approximately 0.66 inch in length, as measured from front edge to back edge near the center (the front edge facing away from the output orifice). The shelf extends approximately 0.37 inch beyond the major vertical surface of the deflector (i.e., the surface transverse to the fluid flow). Thus, the forwardly-extended portion of the shelf is approximately 56% of the total length thereof.

Technical bulletin "Model CHEC—8.0 K-factor Concealed Horizontal Extended Coverage Quick Response Light Hazard, Sidewall Sprinklers" (Tyco Fire Products, Lansdale, Pa., April 2004) shows a horizontal sidewall sprinkler having a deflector with a horizontal shelf. The shelf is perpendicular to the frame arms and is approximately 0.880 inch in length, as measured from front edge to back edge near the center (the front edge facing away from the output orifice). The shelf has a protrusion in the center of the forward edge. The shelf extends approximately 0.56 inch beyond the major vertical surface of the deflector (i.e., the surface transverse to the fluid flow). Thus, the forwardly-extended portion of the shelf is approximately 63.6% of the total length thereof. This document also shows the sprinkler mounted in a support cup assembly with a cover. The sprinkler is positioned in the support cup such that a frangible glass bulb is completely

enclosed within the support cup and does not extend beyond the wall surface (i.e., the "retainer flange mounting surface"). The hub at which the frame arms meet is positioned so that a portion of the hub falls within the gap between the flange and the cover (i.e., within the "preset gap).

Some conventional horizontal sidewall sprinklers are installed in such a manner that their structure is visible, which is not aesthetically pleasing. Moreover, the sprinkler's extending structure tends to invite improper use of the sprinkler, for example to hang clothing or other items. Such improper use is undesirable, as it may render the sprinkler inoperable or cause unintended activation. Some conventional horizontal sidewall sprinklers are mounted in a support cup with a cover, such that the thermally-responsive element is positioned completely within the support cup. This arrangement tends to reduce air flow across the thermally-responsive element and correspondingly reduces the sensitivity of the sprinkler. Moreover, such configurations often include deflector shelves that extend significantly beyond the vertical surface of the deflector and require covers that extend further from the wall.

SUMMARY OF THE INVENTION

In one aspect, the present invention provides a fire protection sprinkler, including a body having an output orifice and a flange, a seal cap to seal a flow of fluid from the output orifice, and a thermally-responsive element positioned to releasably retain the seal cap. Housing members extend from the flange, and rods are slidably contained within the housing members and extend into the flange. A deflector is connected to ends of the rods.

Embodiments of the present invention may include one or more of the following features. The thermally-responsive element may include a pair of levers, each of which is connected to a plate of a soldered link. The rods may slide between a first position within the housing member, to a second, lower position extending from the housing member. In the second position, the rods may engage the housing members so as to assist in maintaining the deflector in a relatively stable position. Each of the rods may have at least one cylindrical portion and at least one frustoconical portion. Each of the housing members also may have at least one cylindrical portion and at least one frustoconical portion. The frustoconical portion of the rod may lodge in a frustoconical portion of the housing member.

The deflector may include a conical portion facing the output orifice and radial slots. At least two sides of the deflector may be substantially linear. The deflector may include tab portions with holes configured to receive ends of the rods, to connect the deflector to the rods.

Embodiments may further include a support cup having a substantially cylindrical outer surface, with the sprinkler mounted in the support cup. The height of the outer surface of the support cup in an axial direction may be less than that of the rods. A substantially cylindrical escutcheon having a flange may be installed in the support cup so as to surround the sprinkler. A substantially flat cover may be releasably mounted on the flange of the escutcheon. The deflector may move from a first position to a second, lower position upon release of the cover.

In another aspect, the present invention provides a fire protection sprinkler, including a body having an output orifice and a flange, a seal cap to seal a flow of fluid from the output orifice, and a thermally-responsive element positioned to releasably retain the seal cap. The sprinkler further includes deflector support members extending from the flange and a deflector connected to the deflector support members. In embodiments of this aspect, the deflector support members may extend through the flange.

In another aspect, the present invention provides a fire protection sprinkler, including a body having an output orifice and a flange, a seal cap to seal a flow of fluid from the output orifice, and a thermally-responsive element positioned to releasably retain the seal cap. The sprinkler further includes deflector support members having movable portions configured to move from a first position to a second position. A deflector is connected to the movable portions of the deflector support members. In the first position, the movable portions of the deflector support members are within the flange, and in the second position, the movable portions of the deflector support members are in a lower position, below the flange.

In another aspect, the present invention provides a horizontal sidewall fire protection sprinkler including a body having an output orifice, a seal cap to seal a flow of fluid from the output orifice, and a thermally-responsive element positioned to releasably retain the seal cap. The sprinkler also includes a deflector having a substantially vertical face that is transverse to a direction of fluid flow from the output orifice, and a substantially horizontal shelf positioned above and substantially perpendicular to the vertical face. A portion of the horizontal shelf extends in the direction of fluid flow by a first length, with respect to the vertical face, and this first length is less than about half of a total length of the horizontal shelf in the fluid flow direction.

Embodiments of the present invention may include one or more of the following features. The first length may be about 35% or less of the total length of the horizontal shelf. The horizontal shelf may include an inclined portion on a forward edge thereof, which may extend across a majority of a width of the horizontal shelf. The inclined portion may be substantially planar.

The vertical face of the deflector may have notches that are oriented about an opening formed in the deflector, between the vertical face and an underside of the horizontal shelf. The vertical face of the deflector may include a folded portion at a bottom edge thereof. The folded portion may form an angle, possibly of about 2°, with respect to the vertical face. The vertical face of the deflector may have a substantially rectangular opening near a bottom edge thereof.

The horizontal sidewall fire protection sprinkler also may include a support cup having a substantially cylindrical outer surface, a front edge in the direction of fluid flow, and a back edge. The support cup may have a raised mounting platform in which the body is mounted. The mounting platform may be closer to the front edge of the support cup in an axial direction thereof than to the back edge. A distance between the mounting platform and the back edge of the support cup in the axial direction may be at least about twice a distance between the mounting platform and the front edge of the support cup. The sprinkler also may include an escutcheon having a substantially cylindrical outer surface configured to fit inside the outer surface of the support cup. A cover may be attached to a mounting flange of the escutcheon.

In other embodiments, the sprinkler may include a support cup in which the sprinkler body is mounted. The support cup may have an outer surface configured to be positioned within a cavity in a wall, and an escutcheon with an outer surface configured to fit inside the outer surface of the support cup and a flange on a front edge of the outer surface (the flange being configured to mount against a surface of the wall).

In another aspect, the present invention provides a fire protection sprinkler including a body with an output orifice scaled with a seal cap, a thermally-responsive element posi-

tioned to releasably retain the seal cap, and a deflector positioned a distance from the output orifice in a direction of fluid flow. The sprinkler further includes a support cup having a raised mounting platform configured to receive the body. The support cup has a substantially cylindrical outer surface, a front edge in the fluid flow direction, and a back edge. The mounting platform is closer to the front edge of the support cup in an axial direction thereof than to the back edge of the support cup.

Embodiments of the present invention may include one or more of the following features. An escutcheon may be provided having a substantially cylindrical outer surface configured to fit inside the outer surface of the support cup. A cover may be attached to a mounting flange of the escutcheon. A distance between the mounting platform and the back edge of the support cup in the axial direction may be at least about twice a distance between the mounting platform and the front edge of the support cup.

In yet another aspect, the present invention provides a horizontal sidewall sprinkler that includes a body having an output orifice and a flange, the body having an axis in an output direction. The sprinkler also includes a seal cap to seal a flow of fluid from the output orifice, and a thermally-responsive element positioned to releasably retain the seal cap at a first predetermined temperature. The sprinkler further includes a plurality of housing members extending from the flange and a plurality of rods, each rod slidably contained within one of the housing members and extending into the flange. The sprinkler also includes a deflector connected to ends of the rods. The deflector includes a first surface extending in a direction transverse to the rods and a second surface connected to the first surface extending in a direction parallel to a plane passing through the rods. Each of the rods comprises at least one cylindrical portion and at least one frustoconical portion, and each of the housing members comprises at least one cylindrical portion and at least one frustoconical portion, and at least one frustoconical portion of the rod lodges in at least one frustoconical portion of the housing member.

These and other objects, features and advantages will be apparent from the following description of the preferred embodiments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more readily understood from a detailed description of the preferred embodiments taken in conjunction with the following figures.

FIG. **1** is an isometric view of a pendent fire protection sprinkler according to one preferred embodiment.

FIG. **2** is a sectional view of the sprinkler installed in the support cup, with the deflector in the deployed position.

FIG. **3** is a sectional view of the sprinkler and support cup, showing the levers and fusible link.

FIG. **4** is an isometric view of the fusible link.

FIG. **5** is an isometric view of a lever.

FIG. **6** is an isometric view of the underside of the sprinkler body showing part of an outlet orifice.

FIG. **7** is an isometric view of the load yoke.

FIG. **8** is a sectional view of the sprinkler body showing the housing members of the deflector support members.

FIG. **9** is an isometric view of a rod that forms part of the deflector support member.

FIG. **10** is an isometric view of the deflector.

FIG. **11** is a sectional view of the deflector and the conical member.

FIG. **12** is an isometric view of the sprinkler installed in the support cup, escutcheon, and cover assembly.

FIG. **13** is a sectional view of the sprinkler installed in a ceiling.

FIG. **14** is a perspective view of an embodiment of a horizontal sidewall sprinkler installed in a support cup assembly of a non-concealed configuration.

FIG. **15** is a top view of the horizontal sidewall sprinkler.

FIG. **16**A is a side sectional view of the horizontal sidewall sprinkler.

FIG. **16**B is an exploded view of a portion of the horizontal sidewall sprinkler identified in FIG. **16** showing an alternate configuration of the attachment of the hub to the deflector.

FIG. **17** is an isometric view of the horizontal sidewall sprinkler deflector.

FIG. **18** is a rear plan view of the deflector.

FIG. **19** is a side plan view of the deflector.

FIG. **20** is a perspective exploded view of the horizontal sidewall sprinkler installed in a support cup/escutcheon/cover assembly of a concealed configuration.

FIG. **21** is a perspective view of the escutcheon.

FIG. **22** is a top sectional view of the support cup/escutcheon/cover assembly of the concealed configuration, showing the sprinkler mounted therein.

FIG. **23** is a side sectional view of the support cup/escutcheon/cover assembly of the concealed configuration, showing a side sectional view of the sprinkler.

FIG. **24** is a rear isometric view of the support cup of the concealed configuration.

FIG. **25** is a side sectional view of the support cup of the concealed configuration.

FIG. **26** is an isometric view of a horizontal sidewall fire protection sprinkler of the present invention.

FIG. **27** is an isometric view of the horizontal sidewall sprinkler deflector of FIG. **26**.

FIG. **28** is a side plan view of the deflector of FIG. **26**.

FIG. **29** is a rear plan view of the deflector of FIG. **26**.

FIG. **30** is a sectional view of a horizontal sidewall sprinkler of FIG. **26** in an assembled condition.

FIG. **31** is a sectional top view of the horizontal sidewall sprinkler of FIG. **26** in another operating condition.

FIG. **32** is a perspective exploded view of the horizontal sidewall sprinkler installed in a support cup/escutcheon/cover assembly of a concealed configuration.

FIG. **33** shows the horizontal sidewall sprinkler and support cup of FIG. **32** with the cover assembly installed.

FIG. **34** is a sectional view of the sprinkler of FIG. **26** installed in a wall.

DETAILED DESCRIPTION

As shown in FIGS. **1** and **2**, a pendent fire protection sprinkler **100** in accordance with the present invention has a body **110** with a threaded base **120** for connection to a conduit (not shown) for supplying pressurized fire-extinguishing fluid, such as water. The body **110** has an axial bore **125** with an outlet orifice **130** from which the fluid is output upon release of a seal cap **135**. The output orifice **130** may have a diameter of, for example, 3/8 or 7/16 inch. The sprinkler may have a nominal K-factor of, for example, 4.3 or 5.6, respectively, which is defined by $K=Q/\sqrt{p}$, where Q is the flow rate in gallons per minute and p is the residual pressure at the inlet of the sprinkler in pounds per square inch. The body **110** also has a hexagonal flange **140** around its output end. Of course in other embodiments, the flange **140** may have other shapes, including, for example, a rectangle and a diamond shape.

A deflector **145** is coupled to two deflector support members **150** on opposite sides of the sprinkler body **110**. Each of the support members **150** includes a housing member **155**, which extends downward from the flange **140** of the sprinkler body **110**, and a rod **165**, which is movable with respect to the housing member **155**.

For example, the housing member **155** may be a tubular structure positioned within and extending downward from a hole **160** in the flange **140**, and the rod **165** may be a solid, generally cylindrical member contained within the housing member **155**. However, numerous other configurations for the housing members **155** and rods **165** also are possible. For example, the rods **165** may be tubular members, rather than solid members. Although the configuration of the preferred embodiment of the housing members **155** and rods **165** are shown in FIGS. **8** and **9**, other shapes are possible as well, e.g., square, hexagonal, cylindrical, telescopic, etc. In addition, although in the preferred embodiment the flange **140** and housing members **155** are separate components, the present invention is not so limited, and those components may be configured as a unitary structure or having multiple components.

During operation, the rods **165** slide from an initial position, in which a large portion of the length of the rod **165** is within the housing member **155** (as shown in FIG. **1**) to a deployed position, in which a substantial portion of the length of the rod **165** extends from the bottom of the housing member **155** (as shown in FIG. **2**). Accordingly, in the deployed position, the deflector **145** moves downward along with the rods **165** (see FIG. **2**).

The sprinkler **100** is mounted in a support cup **170** having a cylindrical, threaded outer wall **175**, which surrounds a portion of the installed sprinkler **100** and, as discussed below, allows for installation into a ceiling cavity. The support cup **170** also has a mounting platform **305** (see FIG. **3**) with a hole in the center into which the sprinkler body **100** is inserted. The hole has a threaded rim portion **310** or tabs configured to interlock with the threads of the sprinkler base **120**.

As shown in FIG. **3**, the sprinkler also has a thermally-responsive element **315** that holds the seal cap **135** in place over the output orifice **130**, e.g., a fusible soldered link **320** attached to the ends of two levers **325**. As shown in FIG. **4**, the link **320** comprises two thin, metal plates **405**, e.g., beryllium-nickel alloy. The metal plates **405** may also be formed of a nickel alloy. The plates **405** overlap such that a rectangular opening **410** in each plate **405**, in which the ends of the levers **325** are positioned, is aligned with a slot **420** or open portion in the other plate **405**. The plates **405** are attached with solder that melts at a predetermined temperature. The link **320** separates at the predetermined temperature, due to the force applied by the levers **325**, allowing the levers **325** to swing outward (FIG. **3**). This in turn releases the seal cap **135** and allows the fluid to be output from the orifice **130**. Of course, other types of thermally-responsive elements may be used, including, but not limited to, for example, a frangible bulb and lever assembly, or a sensor, strut, and lever assembly.

Each lever, as shown in FIG. **5**, is an elongated, thin, metal member, e.g., copper alloy with a thickness of 0.050 inch. Each lever **325** has a wider tab portion **510** located near the end **520** that inserts into one of the openings **410** in the link plates **405**. The tab portion **510** rests against the plates **405**, so as to maintain the position of the lever **325** with respect to the plates **405**. The other end **530** of each lever **325** is inserted into one of a pair of arcuate, rectangular slots **610**, as shown in FIG. **6**, formed inside the bore **125** on either side of the outlet orifice. The slots **610** are positioned 90° apart from the deflector support members **150** in the plane of the flange **140**.

Referring again to FIG. **3**, the levers **325** swing outward upon release of the fusible link **320** due to the force of the fluid in the conduit against the seal cap **135** and a pre-tension force supplied by a loading yoke **710**, as shown in FIG. **7**. The loading yoke **710** is a cylindrical member with a threaded bore **720** and a circumferential flange **730** at one end. A load screw **740** (see FIG. **3**) extends completely through the bore **720** of the yoke **710** and rests in an indentation in the seal cap **135**. The yoke **710** is forced against the levers **325** by the tightening of the load screw **740** against the seal cap **135**, thereby forcing the levers **325** away from one another.

As shown in the cross-sectional view of FIG. **8**, the housing members **155** of the deflector support members **150** are positioned in through-holes **160** formed in the flange **140** of the sprinkler body **110**, such that their axes are spaced apart by about 1.125 inches (in this embodiment). Each housing member **155** is about 1.13 inches in length and is formed of thin metal, e.g., copper alloy. The top end of each housing member **155** has a flange **810** to hold it in place. The outer perimeter of this flange **810** is circular, with a cutout to allow the housing member **155** to be positioned closer to the sprinkler body **110**.

At the top of each housing member **155** (i.e., the flanged end) is a first cylindrical portion **820**, which is about 0.35 inch in length and about 0.26 inch in diameter. This is followed by a first frustoconical portion **825** having a length of 0.08 inch and forming an angle of about 8.0° with respect to the longitudinal axis of the housing member. A second cylindrical portion **830** adjoins, with a diameter of about 0.25 inch and a length of 0.20 inch. This is followed by a second frustoconical portion **835** having a length of 0.35 inch and forming an angle of about 8.6° with respect to the axis of the housing member. A third cylindrical portion **840** is provided at the end of the housing member **155**, which has a length of about 0.11 inch and a diameter of about 0.2 inch. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values.

As shown in FIG. **9**, the rods **165** of the deflector support members **150**, which slide between a position within the housing members **155** and an extended position, are each about 1.28 inches in length. Each rod **165** has a frustoconical portion **910** at the top, which is about 0.29 inch in length and forms an angle of about 4.5° with respect to the longitudinal axis of the rod. The diameter of the frustoconical portion **910** is about 0.155 inch at the top end and about 0.11 inch at the bottom end. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values

A conical void **920**, which has a length of about 0.07 inch, an opening diameter of about 0.085 inch is formed in the end of the rod **165**. The conical void **920** aids in material flow during the formation of the frustoconical portion **910** of the rod **165**. The frustoconical portion **910** helps hold the rod **165** in rigid position at the bottom of the housing member **155** in the deployed position. While in the preferred embodiment the rod has a void in an end thereof, the present invention is not limited to this configuration and may include solid rods without a void or indentation, or hollow rods.

The frustoconical portion **910** is followed by a first cylindrical portion **930** of about 0.56 inch in length and a diameter of about 0.11 inch. A second cylindrical portion **940** of about 0.30 inch in length and about 0.093 inch in diameter is formed, and the top end of this portion blended to the surface

of the first cylindrical portion by a curved surface **950** having a radius of 0.08 inch. A third cylindrical portion **960** having a length of about 0.115 inch and a diameter of about 0.082 inch is formed at the bottom of the rod **165**. The surface of the third cylindrical portion **960** is blended to the surface of the second cylindrical portion **940** by a curved surface **970** having a radius of about 0.08 inch. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values.

When the sprinkler is deployed (see FIG. **2**), the first frustoconical portion **910** of the rod **165** lodges in the second frustoconical portion **835** and third cylindrical portion **840** of the housing member. By using the above described configuration, the deflector is more stable when deployed, allowing for a consistent sprinkler spray pattern. By contrast, without such a configuration, the force of the fluid output may cause the deflector to wobble or shift to, and possibly jam in, an askew position, resulting in an undesirable spray pattern.

The stability of this configuration is in part attributed to the resiliency in the first frustoconical portion **910** of the rod **165**, which provides a substantially locking fit between the rod **165** and the housing member **155**. This in turn provides stability to the deployed deflector **145** when it is exposed to the stream of output fluid, thereby preventing undesirable vibration or movement of the deflector **145**. While this is the preferred embodiment, the invention is not limited to this particular configuration, and may include other deflector support members.

The deflector **145**, which is shown in detail in FIGS. **10** and **11**, has an opening **1010** in the middle that is configured to receive a conical member **1020**. The conical member **1020**, which has an outer diameter of 0.7 inch and an included angle of 130°, faces the output orifice **130** to assist in the dispersion of the output fluid and to improve the stability of the deployed deflector **145**. A conical indentation **1030** having an included angle of about 118° to about 120° is formed in the base of the conical member **1020** (which has a diameter of 0.245 inch) to allow it to achieve a secure press fit in the opening **1010** of the deflector **145**. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values. The conical member **1020** also helps prevent the seal cap **135** and other ejected components from becoming lodged behind the deflector **145** upon deployment of the sprinkler.

The deflector **145** has radial slots **1040** around the perimeter thereof, arrayed around the opening **1010** for the conical member **1020**. The slots **1040** extend inward to within a distance of the opening **1010** to form a generally circular central portion **1050** of the deflector **145** surface. Two tab portions **1060** extend from the sides of the deflector **145** with a downward angle of about 10° (with respect to the plane of the deflector) to provide mounting holes **1070** for the rods **165** extending from the deflector support members **150**. The outer edges **1080** of the other two sides of the deflector are linear (see FIG. **10**).

As shown in FIGS. **12** and **13**, the sprinkler **100** installs within a support cup **170**, escutcheon **1210**, and cover **1220** assembly to form a concealed configuration. Such a configuration is particularly desirable for residential application due to its low profile and aesthetically pleasing appearance. The escutcheon **1210**, which is cylindrical and has a circumferential flange **1215** on its outwardly facing end, installs with a press or threaded fit into the ridged outer surface (walls **175**) of the support cup **170**. The escutcheon **1210** is formed of metal, e.g., copper alloy.

A flat, circular cover **1220**, which also is formed of metal, e.g., brass, is mounted on raised portions around the periphery of the escutcheon flange **1215** (see FIG. **13**). The cover **1220** attaches to these raised portions with solder that is designed to melt at a predetermined temperature, e.g., 135° F., to allow for release of the cover **1220**. The raised portions result in a gap between the cover **1220** and the escutcheon **1210**, which allows air flow to reach the sprinkler **100**. The release of the cover **1220** allows the deflector **145** to drop down into the deployed position. At a second predetermined temperature, e.g., 165° F., the fusible soldered link **320** separates, as described above, to initiate the flow of fluid from the sprinkler.

To install the sprinkler, the support cup **170**, which has a diameter of, e.g., 2.28 inches, is inserted in a cavity in the ceiling **1230** having a diameter of, e.g., about 2⅝ inches, and the threaded base **120** of the sprinkler is connected to the output fitting **1235** of a conduit **1240**. The escutcheon **1210** and cover **1220** assembly is then installed in the support cup **170** so that the escutcheon flange **1215** rests on the outer surface of the ceiling **1230** (the outer surface of the cover is about 3/16 inch from the surface of the ceiling due to the gap between the flange and cover). While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values.

The support cup **170** and escutcheon **1210** are configured to allow for an adjustment to accommodate variations in the distance between the face **1250** of the conduit output fitting **1235** and the surface of the ceiling **1230**, which is referred to as the "field adjustment." The field adjustment is sometimes needed, because the deflector **145** must be properly located below the ceiling **1230** in its deployed position, but it is difficult to precisely position sprinkler conduits **1240** with respect to the ceiling **1230** surface, due to the practicalities of building construction. To ensure the correct position of the deployed deflector **145**, the distance between the face **1250** of the conduit output fitting **1235** and the ceiling **1230** should not be more than 2 inches.

The field adjustment is achieved by allowing the escutcheon **1210** to be positioned with a varying degree of overlap with the outer walls **175** of the support cup **170**. The support cup **170** and escutcheon **1210** are configured so that any secure engagement between these components results in a proper position for the deployed deflector **145**.

The amount of field adjustment, which in this example is 0.5 inch, is determined by the length of the rods **165** of the deflector support members **150**, because the length of the rods **165** determines the amount of variation that can be accommodated in the position of the conduit **1240** relative to the ceiling line **1230**. In other words, the rods **165** may be completely retracted within the housing member **155** before deployment, such as when the conduit **1240** and, therefore the sprinkler **100**, is positioned as close as possible to the ceiling line **1230**. Alternatively, the rods **165** may be nearly ¾ extended before deployment, such as when the conduit **1240** is positioned as far as possible above the ceiling line **1230**. The length of the rods **165**, in turn, determines the height of the outer walls **175** of the support cup **170**. Thus, the outer walls **175** of the support cup **170** must have a height of slightly more than 0.5 inch in the example described herein.

Configuring the deflector support members **150** such that the rods **165** extend through the housing members **155** and the flange **140** allows for the use of a shallower cup, because the depth of the support cup is primarily determined by the length of the rods **165**. This in turn results in the thermally-responsive element being located closer to the ceiling line, thereby improving sprinkler sensitivity. By contrast, in conventional concealed sprinklers, the guide pins coupled to the deflector are generally positioned below the flange, thereby requiring a deeper support cup (because the depth of the support cup is determined by the length of the guide pins plus the flange thickness). Consequently, the thermally-responsive element is located farther from the ceiling line, resulting in reduced sprinkler sensitivity.

As shown in FIG. **14**, a horizontal sidewall sprinkler **1400** in accordance with the present invention may be installed in a non-concealed configuration in a support cup assembly **1410**. The support cup **1410** assembly is mounted in a wall **1420**, a predetermined distance below a ceiling. The sprinkler **1400** is connected to a conduit (not shown) behind the wall **1420** that provides pressurized fire-extinguishing fluid, such as water.

As shown in the top view of FIG. **15** and side section view of FIG. **16**A, the sprinkler **1400** has two frame arms **1505** that extend from a threaded base portion **1510** and meet at a hub **1515** (see FIG. **16**A), on which a deflector **1520** is mounted. The deflector **1520** has a horizontal shelf **1525** and a vertical face **1530**, approximately perpendicular to the shelf **1525**. The fire-extinguishing fluid flows both over the top of and under the shelf **1525**.

The sprinkler **1400** also has a thermally-responsive element, such as for example a frangible bulb **1535**, positioned between the hub **1515** and a seal cap **1540** to hold the seal cap in place over the output orifice **1545**. The bulb **1535** is designed to break at a predetermined temperature, thereby releasing the seal cap **1540** (due to the pressure of the fluid in the conduit) and allowing the fluid to be output from the orifice **1545**. The output orifice may have a diameter of, for example, ½ inch NPT (national pipe thread). The sprinkler may have a K-factor of, for example, 4.4, which is defined by $K=Q/\sqrt{p}$, where Q is the flow rate in gallons per minute and p is the residual pressure at the inlet of the sprinkler in pounds per square inch. Of course, other types of thermally-responsive elements may be used, including but not limited to, for example, a fusible link assembly, or a sensor, strut, and lever assembly.

The deflector shelf **1525** has an upwardly-angled, inclined portion **1550** on the front edge, i.e., the edge facing away from the output orifice **1545**. The inclined portion **1550** provides an upward vertical deflection to the fluid flow, which in turn imparts an upward trajectory to a portion of the fluid flow. This upward trajectory results in the fluid reaching a higher point on the opposite wall, which helps the sprinkler meet opposite wall wetting height requirements. The incline **1550** is substantially planar and extends across a large portion of the width of the shelf **1525**. This configuration helps provide a uniform upward deflection to a significant portion of the output stream without imparting substantial additional horizontal deflection.

As shown in FIG. **16**A, the deflector **1520** is attached to the end of the hub **1515** via a fastener that passes though an opening **1555** in the vertical face **1530** of the deflector **1520**. Also, in an alternate configuration shown in FIG. **16**B, the hub **1515** itself includes a portion that extends through the opening **1555** and is flared over the opening **1555** to attach the deflector to the hub. In the embodiment shown, the deflector shelf **1525** is horizontal, and is parallel with the frame arms **1505**, but the shelf **1525** also may be angled slightly upward to help achieve a desired spray pattern.

The deflector **1520**, as shown in FIGS. **17-19**, may be formed by stamping a thin piece of metal to form a flat blank (not shown) having a desired outer shape, with internal cutouts. For example, the blank may be formed of brass, or brass alloy, and may for example be about 0.05 inch thick. While this dimension is present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with a value that departs somewhat from this, and to make a sprinkler that would be operable without using these exemplary values. The blank is folded to achieve the final shape of the deflector **1520**, including the horizontal shelf **1525**. As noted above, the vertical face **1530** of the deflector **1520** has an opening **1555** in a central portion thereof to receive the fastener that attaches it to the hub **1515** (see FIG. **16**). Above the fastener opening **1555** is an upper portion **1810** of the vertical face **1530** with notches **1820** (see FIG. **18**) formed on the edge thereof. A portion of the output fluid flows through the opening **1830** formed between the upper portion **1810** of the vertical face **1530** and the bottom of the shelf **1525** and is dispersed by the notches **1820** to help achieve a desired spray pattern.

The vertical face **1530** also has a lower portion **1840** extending below the fastener opening **1555**. The lower portion **1840** is generally rectangular with notches **1850** formed on the sides and a rectangular window **1860** formed near the bottom of the lower portion **1840** that allows a portion of the output fluid to pass through. The bottom edge of the lower portion **1840** has a folded portion **1870** below the window **1860** that provides a thicker, more rounded bottom edge **1880** to the lower portion **1840**. The folded portion **1870** is formed, for example, by folding a tab provided in the flat blank. This configuration helps reduce the dispersive edge effects of the bottom edge **1880**, which may cause fluid to spray back toward the sprinkler. Thus, the window **1860** and folded portion **1870** help to project more fluid in front of the plane of the vertical face **1530** and also help to create a more uniform spray pattern on the floor. This in turn helps the sprinkler meet floor collection (i.e., density) requirements.

Two arm portions **1890** of the deflector, which extend from the sides of the fastener opening **1555**, are formed in the fabrication process discussed above by cutting out an opening **1830** in the flat blank between the shelf **1525** and the vertical face **1530**. The arm portions **1890** extend in the plane of the vertical face **1530** and then, as shown in the side view of FIG. **19**, bend approximately 85° to form two backwardly extending (i.e., toward the base of the sprinkler) arm portions **1905** in a horizontal plane approximately parallel to the shelf **1525**. These backwardly extending arm portions **1905** then bend to form part of the back edge of the deflector shelf **1525**. The shelf **1525** forms an angle of about 90° with respect to the vertical face **1530** and about 185° with respect to the backwardly extending arm portions **1905**. In addition, the tab of the folded portion **1870** at the bottom of the vertical face forms an angle of about 2° with respect to the vertical face **1530**.

FIG. **19** also shows that the majority of the length of the deflector shelf **1525** (as measured in the generally horizontal direction of fluid output) is rearwardly positioned with respect to the vertical face **1530** of the deflector **1520**. In other words, the portion of the shelf **1525** extending in front of the vertical face **1530** of the deflector is less than about 50% of the total length of the shelf. For example, the shelf **1525** may have a length of about 0.65 inch, but may extend forward beyond the vertical face **1530** of the deflector by only about 0.23 inch. In such a case, the forwardly-extended portion of the shelf

would be only about 35% of the total length of the shelf. Other proportions also are possible. For example, the forwardly-extended portion of the shelf may be about one third or less of the total length. Thus, the shelf **1525** is "shorter" than a conventional horizontal sidewall design, in the sense that it does not extend as far forward beyond the vertical face **1530** of the deflector **1520**. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values.

The shorter shelf **1525** results in less bending stress and greater stability for the deflector **1520**, while maintaining the required spray pattern. As shown in FIG. **14**, the shorter shelf **1525** also results a shorter overall length for the sprinkler **1400**, which helps reduce the risk of damage to installed units and improves the aesthetic characteristics of the sprinkler. In addition, as discussed below, the shorter shelf allows for the use of a lower-profile cover in the concealed configuration (i.e., a cover that is narrower and/or does not extend as far from the wall surface).

In an alternative embodiment, as shown in FIG. **20**, the sprinkler **1400** depicted in FIGS. **15-19** may be mounted in a concealed configuration in a support cup/cover assembly **2000**. The support cup **2010** is generally circular, with a cylindrical, ridged outer surface **2015** around its circumference and a raised mounting platform **2020** positioned in its central portion. The cup **2000** is configured to be mounted in a cavity in a wall, a predetermined distance below the ceiling. The sprinkler **1400** is mounted in, and extends horizontally, from the platform **2020** in the center of the support cup **2010**. An escutcheon **2030** and cover **2035** assembly, discussed in further detail below, is placed over the sprinkler **1400** to protect it from damage and provide an aesthetically pleasing appearance.

FIG. **22** shows a top sectional view (looking down on the upper surface of the deflector shelf **1525**) of the support cup/escutcheon/cover assembly **2000** with the sprinkler **1400** installed. FIG. **23** shows a side sectional view of this assembly, with the sprinkler **1400** shown in section. The cup **2010**, as noted above, has a ridged outer surface **2005** around its circumference and a raised mounting platform **2020** in the center. The sprinkler **1400** is mounted in the platform **2020** by screwing the threaded base portion **1510** into an opening in the center of the platform **2020**. The opening has an inwardly-extended, threaded rim **2040** (as shown) or alternatively, tabs, that act as thread guides to interlock with the threaded base portion **1510** to hold the sprinkler **1400** in place. The mounting platform **2020** has a significantly larger radius that the base portion **1510** of the sprinkler **1400**, so as to leave an annular volume **2050** around the base **1510**, to allow sufficient room for connection of the sprinkler to the output head (e.g., fitting **123**, FIG. **13**) of the conduit (e.g., conduit **1240**, FIG. **13**).

A portion of the sprinkler **1400** is surrounded by a cylindrical escutcheon **2030**. As shown in FIG. **21**, the escutcheon **2030** has a circumferential flange **2310** on its outwardly facing end. The escutcheon **2030** installs with a press fit into the ridged outer surface **2005** of the support cup **2010** (see FIGS. **23** and **23**), so that the flange **2310** rests on the outer surface of the wall in which the cup **2010** is installed. The escutcheon **2030** may be formed, for example, of metal, e.g., steel or brass, having a thickness of about 0.020 inch. The escutcheon **2030** in FIG. **21** has tabs **2320** located on the cup-installation edge of the cylindrical portion, in order to act as stops to ensure the escutcheon **2030** is not inserted into the cup **2010** beyond a desired depth.

The escutcheon flange **2310** includes raised portions **2330** around its periphery that act as mounting points for the cover **2035**. The cover **2035** is connected to these raised portions **2330**, resulting in a gap **2340** (see FIGS. **22** and **23**) being formed between the cover **2035** and the escutcheon **2030**, which allows air flow to reach the sprinkler **1400**. The cover **2035** is attached to these mounting points **2330** with solder that is designed to melt at a predetermined temperature to allow for release of the cover **2035**. Small springs **2350** formed of thin, bent metal tabs (only one of which is depicted), or similar spring structures, may be installed at the mounting points **2330** to urge the cover **2035** away from the flange **2310**, to help insure proper ejection of the cover **2035**.

FIG. **24** is a rear isometric view of the support cup **2010** for the concealed configuration, i.e., a view from the side opposite that from which the sprinkler extends. FIG. **25** is a side sectional view oriented so that the installed sprinkler would extend downward with respect to the drawing sheet. As noted above, the sprinkler **1400** is installed in a mounting platform **2020** in the central portion of the support cup **2010** (see FIGS. **22** and **23**). The threaded base portion **1510** of the sprinkler **1400** fits within an opening **2405** in the mounting platform **2020** and interlocks with a threaded rim **2040** within the opening **2405**. The mounting platform **2020** is forwardly-extended, such that the surface of the mounting platform **2020** is closer to the forward facing edge **2410** of the support cup **2010** than the rear edge **2420** in the axial direction. For example, the distance from the surface of the mounting platform **2020** to the forward edge **2410** of the support cup **2010** may be about 0.25 inch, while the distance to the rear edge **2410** may be about 0.5 inch. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values.

The forwardly-extended mounting platform **2020** arrangement results in the sprinkler **1400** being positioned so that the thermally-responsive element **1535** extends beyond the wall plane, i.e., beyond the rim **2310** of the escutcheon **2030**. In other words, the thermally-responsive element **1535** extends into the gap **2340** between the escutcheon **2030** and the cover **2035** (see FIGS. **22** and **23**), in the generally horizontal direction, and may extend at least partially into the cover **2035**. Such an arrangement is advantageous in that the thermally-responsive element **1535** is more exposed to the air flow entering the assembly through the gap **2340** between the cover **2035** and the escutcheon **2030**, resulting in improved responsiveness of the sprinkler. This advantage is particularly important for applications requiring faster response time, such as residential applications.

The support cup/cover assembly described above also may be used in conjunction with pendent sprinklers. For example, a pendent sprinkler may be mounted in the support cup installed in a ceiling. The escutcheon/cover assembly is inserted into the support cup so that the flange of the escutcheon is flush with the ceiling. The pendent sprinkler may have arms that meet at a hub, to which a deflector is attached. Alternatively, the pendent sprinkler may be a "frameless" sprinkler, which does not have arms and a hub, but instead has a thermally-responsive element releasably mounted on the sprinkler body to hold the seal cap in place and a drop-down deflector.

In addition, the support cup described above may be used with other types of escutcheons and covers, or without a cover, in either a horizontal or pendent configuration. For example, a pendent sprinkler may be mounted in the support

cup, as described above, mounted in a ceiling. In such a case, the sprinkler would be positioned so that its thermally-responsive element would be more exposed to air flow, due to the forwardly-extended mounting platform in the support cup.

While the present invention has been described with respect to what is presently considered to be the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, the invention is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

As shown in FIGS. **26** and **31**, a sidewall concealed fire protection sprinkler **2600** in accordance with the present disclosure has a structure that combines some features of the sprinkler shown in FIG. **1** with some of the features of the deflector **1520** shown in FIG. **14**. For example, deflector **2620** has a structure similar in many relevant respects to the sidewall horizontal deflector **1520** shown in FIG. **14**. Accordingly, for clarification, like elements among the various figures are shown with like reference numerals.

The sprinkler includes a sprinkler body **110** having an output orifice which may have a diameter of, for example, ½ inch NPT (national pipe thread). The sprinkler may have a K-factor of, for example, 4.4.

The deflector **2620** shown in FIGS. **26-32** and **34** has a horizontal shelf **2625** and a vertical face **2630**, approximately perpendicular to the shelf **2625**. The fire-extinguishing fluid flows both over the top of and under the shelf **2625**.

The deflector shelf **2625** has an upwardly-angled, inclined portion **2650** on the front edge, i.e., the edge facing away from the outlet orifice **130**. The inclined portion **2650** provides an upward vertical deflection to the fluid flow, which in turn imparts an upward trajectory to a portion of the fluid flow. This upward trajectory results in the fluid reaching a higher point on the opposite wall, which helps the sprinkler meet opposite wall wetting height requirements. The incline **2650** is substantially planar and extends across a large portion of the width of the shelf **2625**. This configuration helps provide a uniform upward deflection to a significant portion of the output stream without imparting substantial additional horizontal deflection.

The deflector **2620** is coupled to two deflector support members **150** on opposite sides of the sprinkler body **110**. Each of the deflector support members **150** includes a housing **155** and a rod **165**. The rods **165** of the two deflector support members **150** are connected to the vertical face **2630** of the deflector **2620** at two openings **2656** formed on opposite sides of a central opening **2655** (FIG. **27**) formed in the vertical face **2630**. In the embodiment shown in FIG. **26**, the deflector shelf **2625** is horizontal, and is parallel with two deflector support members **150**, but the shelf **2625** also may be angled slightly upward to help achieve a desired spray pattern.

The deflector **2620**, as shown in FIGS. **26-32** and **34**, may be formed in the same fashion as the deflector **1520** shown in FIG. **17**. On both sides of the central opening **2655** are formed two mounting holes **2656**, discussed below. Above the central opening **2655** is an upper portion **2710** of the vertical face **2630** with notches **2720** (see FIG. **18**) formed on the edge thereof. A portion of the output fluid flows through the opening **2730** (FIG. **29**) formed between the upper portion **2710** of the vertical face **2630** and the bottom of the shelf **2625** and is dispersed by the notches **2720** to help achieve a desired spray pattern.

On a side of the vertical **2630** face opposite the output direction, a conical portion **1020** extends rearwardly. On one side of the vertical face **2630** in the output direction a round flange extends around the rim of central opening **2655**. The flange can be formed as a result of crimping or swedging the conical portion **1020** onto the central opening **2655**.

As discussed above with respect to FIG. **11**, the conical member **1020**, which has an outer diameter of 0.7 inch and an included angle of 130°, faces the output orifice **130** to assist in the dispersion of the output fluid and to improve the stability of the deployed deflector **2620**. A conical indentation **1030** having an included angle of about 118° to about 120° is formed in the base of the conical member **1020** (which has a diameter of 0.245 inch) to allow it to achieve a secure press fit in the central opening **2655** of the deflector **2620**. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values. The conical member **1020** also helps prevent the seal cap **135** and other ejected components from becoming lodged behind the deflector **2630** upon activation of the sprinkler **2600** upon separation of the fusible soldered link **320**, mentioned above in connection with FIGS. **3** and **4**, and discussed hereinbelow.

The vertical face **2630** also has a lower portion **2740** extending below the central opening **2655**. The lower portion **2740** is generally rectangular with notches **2750** formed on the sides and a rectangular window **2760** formed near the bottom of the lower portion **2740** that allows a portion of the output fluid to pass through. A bottom edge **2780** of the lower portion **2740** has a folded portion **2770** below the window **2760** that provides a thicker, more rounded bottom edge **2780** to the lower portion **2740**. The folded portion **2770** is formed, for example, by folding a tab provided in the flat blank. This configuration helps reduce the dispersive edge effects of the bottom edge **2780**, which may cause fluid to spray back toward the sprinkler. Thus, the window **2760** and folded portion **2770** help to project more fluid in front of the plane of the vertical face **2630** and also help to create a more uniform spray pattern on the floor. This in turn helps the sprinkler meet floor collection (i.e., density) requirements.

Two arm portions **2790** (FIG. **29**) of the deflector **2620**, which extend from the sides of the central opening **2655**, are formed in the fabrication process discussed above by cutting out an opening **2730** in the flat blank between the shelf **2625** and the vertical face **2630**. The arm portions **2790** extend in the plane of the vertical face **2630** and then, as shown in the side elevation view of FIG. **28**, bend approximately 85° to form two backwardly extending (i.e., toward the base of the sprinkler) arm portions **2805** in a horizontal plane approximately parallel to the shelf **2625** and parallel to the deflector support members **150**. The mounting holes **2656** are formed in the arm portions **2790**, which are used for coupling the rods **165** to the deflector **2620** such as by crimping. The backwardly extending arm portions **2805** then bend upward and forward towards the rear edge of the deflector shelf **2625**. The rear edge of the shelf **2625** and the portions of the arms **2805** extending from the rear edge of the shelf define a notch **2806**. The notch **2806** extends rearwardly to accommodate an upper edge of the link **315** extending vertically in the notch **2806**. The shelf **2625** forms an angle of about 90° with respect to the vertical face **2630** and about 185° with respect to the backwardly extending arm portions **2805**. In addition, the tab of the folded portion **2770** at the bottom of the vertical face **2630** forms an angle of about 2° with respect to the vertical face **2630**. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart

somewhat from these, and to make a sprinkler that would be operable without using these exemplary values.

FIG. **29** also shows that the majority of the length of the deflector shelf **2625** (as measured in the generally horizontal direction of fluid output) is rearwardly positioned with respect to the vertical face **2630** of the deflector **2620**. In other words, the portion of the shelf **2625** extending in front of the vertical face **2630** of the deflector is less than about 50% of the total length of the shelf. For example, the shelf **2625** may have a length of about 0.65 inch, but may extend forward beyond the vertical face **2630** of the deflector by only about 0.23 inch. In such a case, the forwardly-extended portion of the shelf would be only about 35% of the total length of the shelf. Other proportions also are possible. For example, the forwardly-extended portion of the shelf may be about one third or less of the total length. Thus, the shelf **2625** is "shorter" than a conventional horizontal sidewall design, in the sense that it does not extend as far forward beyond the vertical face **2630** of the deflector **2620**. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values.

The shorter shelf **2625** results in less bending stress and greater stability for the deflector **2620**, while maintaining the desired spray pattern. The shorter shelf **2625** also results a shorter overall length for the sprinkler **2600**, which helps reduce the risk of damage to installed units and improves the aesthetic characteristics of the sprinkler. In addition, as discussed below, the shorter shelf **2625** allows for the use of a flat cover **3201** (FIGS. **32-34**) in the concealed configuration. One result of using the flat cover **3201** is that the cover extends less from the surface of the wall **3401** (FIG. **34**) than truncated conical cover **2035** shown in FIGS. **20-23**, which is viewed by some as improving the aesthetics of the cover.

As shown by comparing FIGS. **30** and **31**, during operation, rods **165** slide from an initial position in which a large portion of the length of the rod **165** is within the housing member **155** to a deployed position (e.g., FIG. **31**), in which a substantial portion of the length of the rod **165** extends from a forward end of the housing member **155**. Accordingly, in the deployed position, the deflector **2620** moves in the output direction along with the rods **165**.

The sprinkler **2600** is mounted in a support cup **170** having a cylindrical, threaded outer wall **175**, which surrounds a portion of the installed sprinkler **2600** and, as discussed below, allows for installation into a wall cavity. The support cup **170** also has a mounting platform **305** with a hole in the center into which the sprinkler body **110** is inserted. The hole has a threaded rim portion **310** or tabs configured to interlock with the threads of the sprinkler base **120**.

As shown in FIG. **31**, the sprinkler also has a fusible soldered link **320**, formed as a fusible link that holds the seal cap **135** in place over the output orifice **130**, e.g., a fusible soldered link **320** attached to the ends of two levers **325**, as shown in FIG. **4** and described above. The link **320** separates at the predetermined temperature, due to the force applied by the levers **325**, allowing the levers **325** to swing outward (FIG. **31**), to in turn, release the seal cap **135** and allow the fluid to be output from the orifice **130**. Of course, other types of thermally-responsive elements may be used, including, but not limited to, for example, a frangible bulb and lever assembly, or a sensor, strut, and lever assembly.

Referring again to FIG. **31**, the levers **325** swing outward upon release of the fusible link **320** due to the force of the fluid in the conduit against the seal cap **135** and a pre-tension force supplied by a loading yoke **710**, shown in FIG. **7**, and described above. A load screw **740** extends completely through the bore **720** of the yoke **710** and rests in an indentation in the seal cap **135**. The yoke **710** is forced against the levers **325** by the tightening of the load screw **740** against the seal cap **135**, thereby forcing the levers **325** away from one another.

The construction of the housing members **155** and the rods **165** shown in FIGS. **30** and **31** correspond to those described above with respect to FIGS. **8-10**. Of course, modifications to the dimensions of the preferred dimensions disclosed with the respect to the structures shown in FIGS. **1-34** are within the spirit and scope of this disclosure. With respect to the frustoconical portion **910** of rod **165** shown in FIG. **9**, in the sidewall concealed sprinkler **2600**, the frustoconical portion **910** helps hold the rod **165** in rigid position at the forward end of the housing member **155** in the deployed position. When the deflector **2620** is deployed (see, e.g., FIGS. **26** and **31**), the first frustoconical portion **910** of the rod **165** lodges in the second frustoconical portion **835** and third cylindrical portion **840** of the housing member **155**. By using the above described configuration, the deflector **2620** is more stable when deployed, allowing for a consistent sprinkler spray pattern. By contrast, without such a configuration, the force of the fluid output may cause the deflector **2620** to wobble or shift to, and possibly jam in, an askew position, resulting in an undesirable spray pattern.

The stability of the configuration of the embodiment described above with respect to FIGS. **26** to **31** is, in part, attributed to the resiliency in the first frustoconical portion **910** of the rod **165**, which provides a substantially locking fit between the rod **165** and the housing member **155**. This in turn provides stability to the deployed deflector **2620** when it is exposed to the stream of output fluid, thereby preventing undesirable vibration or movement of the deflector **2620**. While this is the preferred embodiment, the invention is not limited to this particular configuration, and may include other deflector support members.

As shown in FIGS. **26** and **32**, the sprinkler **2600** installs within a support cup **170**, escutcheon **1210**, and cover **3201** assembly to form a concealed sprinkler assembly **3300** shown assembled in FIG. **33**. The support cup **170** and the escutcheon **1210** correspond to those structures shown in FIGS. **12** and **13**. The cover **3201** includes a plurality of through holes **3202** through which air can pass. Of course, in other embodiments, the cover **3201** is formed without the holes **3202**. Such a cover configuration is particularly desirable for residential applications due to its low profile and aesthetically pleasing appearance. The escutcheon **1210** is generally cylindrical and has a circumferential flange **1215** on its outwardly facing end, and installs with a press or threaded fit into the ridged outer surface (walls **175**) of the support cup **170**. The escutcheon **1210** is formed of metal, e.g., copper alloy.

The flat, circular cover **3201**, can also be formed of metal, e.g., brass, or plastic, and the cover **3201** is mounted on raised portions **1211** around the periphery of the escutcheon flange **1215** (see FIG. **32**). The cover **3201** attaches to these raised portions **1211** with solder that is designed to melt at a predetermined temperature, e.g., 135° F., to allow for release of the cover **3201**. The raised portions **1211** result in a gap **3420** (FIG. **34**) between the cover **3201** and the escutcheon **1210**, which also allows air flow to reach the sprinkler **2600**. The release of the cover **3201** allows the deflector **2620** to move horizontally in the output direction into the deployed position (FIG. **31**) when a second predetermined temperature, e.g., 165° F., is reached and the fusible soldered link **320** separates, as described above, to initiate the flow of fluid from the sprinkler to the deflector **2620**.

The sprinkler **2600** is installed into the support cup **170** in the same fashion as described above with respect to the sprinkler shown in FIG. **1**. However, in the case of the horizontal sidewall concealed sprinkler assembly **3300**, the escutcheon **1210** and cover **3201** assembly is installed in the support cup **170** so that the escutcheon flange **1215** rests on the outer surface of the wall **3401** as shown in FIG. **34** (the outer surface of the cover **3201** is about 3/16 inch from the surface of the wall due to the gap **3420** between the flange **1215** and cover **3201**).

The support cup **170** and escutcheon **1210** are configured to allow for an adjustment to accommodate variations in the distance between the face **3450** of the conduit output fitting **3435** and the surface of the wall **3401**, which is referred to as the "field adjustment." The field adjustment is sometimes needed, because the deflector **2620** must be properly located away from the surface of the wall **3401** in its deployed position (e.g., FIGS. **26** and **31**), but it is difficult to precisely position sprinkler conduits **1240** with respect to the wall **3401** surface, due to the practicalities of building construction. To ensure the correct position of the deployed deflector **2620**, the distance between the face **3450** of the conduit output fitting **3435** and the wall **3401** should not be more than 2 inches.

The field adjustment is achieved by allowing the escutcheon **1210** to be positioned with a varying degree of overlap with the outer walls **175** of the support cup **170**. The support cup **170** and escutcheon **1210** are configured so that any secure engagement between these components results in a proper position for the deployed deflector **2620**.

The amount of field adjustment, which in this example is between 5/16 to 3/8 inch, is determined by the length of the rods **165** of the deflector support members **150**, because the length of the rods **165** determines the amount of variation that can be accommodated in the position of the conduit **1240** relative to the wall surface **3401**. In other words, the rods **165** may be completely retracted within the housing member **155** before deployment, such as when the conduit **1240** and, therefore the sprinkler **2600**, is positioned as close as possible to the wall surface **3401**. Alternatively, the rods **165** may be nearly 3/4 extended before deployment, such as when the conduit **1240** is positioned as far as possible away from the wall surface **3401**. The length of the rods **165**, in turn, determines the height of the outer walls **175** of the support cup **170**. Thus, the outer walls **175** of the support cup **170** must have a height of slightly more than 5/16 to 3/8 inch in the example described herein. While these dimensions are present in this embodiment, it is within the reach of ordinary skill to make a sprinkler that would operate satisfactorily with values that depart somewhat from these, and to make a sprinkler that would be operable without using these exemplary values.

Configuring the deflector support members **150** such that the rods **165** extend through the housing members **155**, and the flange **140** allows for the use of a shallower cup **170**, because the depth of the support cup **170** is primarily determined by the length of the rods **165**. This in turn results in the fusible soldered link **320** (e.g., FIG. **30**) being located closer to the surface of the wall **3401**, thereby improving sprinkler sensitivity.

It is expected that the horizontal sidewall concealed fire sprinkler complies with the distribution requirements of Underwriter Laboratory's (UL) Residential Wall Wetting/Floor Wetting criteria for any given coverage area, but is at least believed to achieve water distribution of 18 feet by 18 feet on the floor below the sprinkler, when installed in accordance with that UL requirement.

While the present invention has been described with respect to what is presently considered to be the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, the invention is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

Therefore, while the invention has been shown and described with respect to example embodiments thereof, it will be understood by those skilled in the art that changes in form and details may be made to these embodiments without departing from the scope and spirit of the invention.

What is claimed is:

1. A pendent fire protection sprinkler, comprising:

a body having an output orifice and a flange, the body having an axis in an output direction, wherein the body is constructed to be connected in a ceiling to a fluid supply conduit, and wherein when the body is connected to the fluid supply conduit above an area to be protected, the axis is angled at an acute angle with respect to the area to be protected;

a seal cap to seal a flow of fluid from the output orifice;

a thermally-responsive element positioned to releasably retain the seal cap at a first predetermined temperature;

a plurality of housing members extending from the flange;

a plurality of rods, each rod slidably contained within one of the housing members and extending into the flange; and

a deflector connected to ends of the rods, the deflector comprised of a planar surface extending in a plane transverse to a plane passing through at least two of the rods,

wherein each of the rods comprises at least one cylindrical portion and at least one frustoconical portion, and each of the housing members comprises at least one cylindrical portion and at least one frustoconical portion, and wherein at least one frustoconical portion of the rod lodges in at least one frustoconical portion of the housing member.

2. The pendent fire protection sprinkler of claim **1**, wherein when the body is connected to the fluid conduit above the area to be protected, the axis is between 45 and 90 degrees with respect to the area to be protected.

3. The pendent fire protection sprinkler of claim **1**, wherein the sprinkler has a K factor of at least 4.3.

4. The pendent fire protection sprinkler of claim **1**, wherein the thermally-responsive element is constructed to be recessed completely behind the surface of the ceiling when the sprinkler is fluidly coupled.

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